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ELECTRICAL GROUND SUPPORT EQUIPMENT CABLE HANDBOOK

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Approved by:

Patrick A. Simpkins, D.B.A.
Director, Engineering Directorate

JOHN F. KENNEDY SPACE CENTER, NASA

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FIGURES

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ABBREVIATIONS, ACRONYMS, AND SYMBOLS

°	degree
°C	degree Celsius
°F	degree Fahrenheit
μm	micrometer
A	ampere
AC	alternating current
AHJ	Authority Having Jurisdiction
Al	aluminum
Al_2O_3	aluminum oxide
AMS	Aerospace Material Specification
APC	angled physical contact
AWG	American Wire Gauge
Cat	category
CATV, CATVP, CATVR	community antenna television and radio distribution cables
CL2, CL2P, CL2R	class 2 cables
CL3, CL3P, CL3R	class 3 cables
cm	centimeter
CM, CMP, CMR, CMG	communications cables
COTS	commercial off-the-shelf
CPE	chlorinated polyethylene
CSPE	chlorosulfonated polyethylene
Cu	copper
DWV	dielectric withstand voltage
e.g.	for example
ECTFE	ethylene chlorotrifluoroethlyene
EDC	Engineering Documentation Center
EIA	Electronic Industries Alliance
EMI	electromagnetic interference
EPR	ethylene propylene rubber
etc.	and so forth
ETFE	ethylene tetrafluoroethylene
FEP	fluorinated ethylene-propylene
fl	fluid
FPL, FPLP, FPLR	power limited fire alarm cables
ft	foot
g	gravity, gram
g-cal	gram-calorie
g_{rms}	root mean square acceleration
gal	gallon
Gb	gigabit
GS	ground system
GSE	ground support equipment

HCl	hydrogen chloride
HDBK	handbook
hr	hour
Hz	hertz
ICEA	Insulated Cable Engineers Association
IDENT	identification
in, "	inch
ITC	instrumentation tray cable
ITU-T	International Telecommunication Union-T
kg	kilogram
km	kilometer
KSC	John F. Kennedy Space Center
L	liter
lb	pound
LC	launch complex
m	meter
Max	maximum
MC	metal-clad
mg	milligram
MHz	megahertz
mi	mile
MI	mineral insulated
MIL	military
Min	minimum
min	minute
mm	millimeter
MMH	monomethylhydrazine
MP, MPP, MPR	multipurpose cables
MS	military standard
MTTR	mean time to repair
MV	medium voltage
NASA	National Aeronautics and Space Administration
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NO, No.	number
NPLF	nonpower limited fire alarm
NPLFP	nonpower limited fire alarm plenum cable
NPLFR	nonpower limited fire alarm riser cable
OD	outside diameter
OFC, OFCP, OFCR	conductive optical fiber cables
OFN, OFNP, OFNR	nonconductive optical fiber cables
OS	overall braided shield
OSDB	overall double-braided (shield)

OTDR	Optical Time Domain Reflectometry
oz	ounce
PC	physical contact
pF	picofarad
PFA	perfluoroalkoxy
PIN	part identification number
PLTC	power-limited tray cable
PSI	pound per square inch
PT	two conductors twisted
PTS	two conductors twisted and shielded
PTSI	two conductors twisted, shielded, and insulated
PVC	polyvinyl chloride
QPL	Qualified Products List
QT	four conductors twisted
QTS	four conductors twisted and shielded
QTSI	four conductors twisted, shielded, and insulated
REV	revision
RF	radio frequency
RFI	radio frequency interference
SAE	Society of Automotive Engineers
SBR	styrene butadiene rubber
ScTP	screened twisted pair
SH	shield
SO	service with oil-resistant jacket
SPC	silver-plated copper
SPEC	specification
SRM	solid rocket motor
SS	single conductor shielded
STD	standard
STP	shielded twisted pair
TC	tray cable; tinned copper
TCSH	tinned-copper shield
TFE	extended polytetrafluoroethylene
TIA	Telecommunications Industry Association
TPE	thermoplastic elastomer
TPR	thermoplastic rubber
TT	three conductors twisted
TTS	three conductors twisted and shielded
TTSI	Three conductors twisted, shielded, and insulated
UL	Underwriters Laboratories
UPC	ultra physical contact
Vp	velocity of propagation
WAD	work authorization document
XLP, XLPE	cross-linked polyethylene

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ELECTRICAL GROUND SUPPORT EQUIPMENT CABLE HANDBOOK

1. SCOPE

Various NASA programs at KSC make maximum use of existing GS. Consequently, the designer must determine whether existing cables can be used as is or be modified, or if new cables are required.

This handbook contains a list of specifications, standards, and reference documents that shall be used in the design, fabrication, and assembly of ground system (GS) cables at the Kennedy Space Center (KSC). The remainder of this handbook contains cross-reference and pictorial indexes of cables and connectors used at KSC.

This handbook addresses all presently designed standard KSC cable subassemblies and information for selecting components for new requirements to interface with existing or new equipment. Also included in Appendix A are Ohm's Law formulas and a conversion table.

2. APPLICABLE DOCUMENTS

2.1 Governmental

John F. Kennedy Space Center (KSC), NASA

79K19600	Electric Cable Fabrication Requirements
120E3100001	Heavy Duty Ground Support Equipment Cable Specification
120E3100002	Light Duty Ground Support Equipment Cable Specification
120E3100003	Ground Support Equipment Cable Fabrication Specification
GP-435	Engineering Drawing Practices
KSC-E-165	Electrical Ground Support Equipment, Fabrication, Specification for
KSC-E-166	Installation and Assembly, Electrical Ground Support Equipment (GSE), Specification for
KSC-NE-8764, Volume I	Crew Launch Vehicle (CLV) Mobile Launcher Solid Rocket Motor Exhaust Plume Induced Environment: Acoustic and Vibration

KSC-NE-8764, Volume II	Crew Launch Vehicle (CLV) Mobile Launcher Solid Rocket Motor Exhaust Plume Induced Environment: Heating Rates and Impact Pressure
KSC-SPEC-E-0024	Cable, Electrical, Shielded, Jacketed For Harness Assemblies, General Specification for
KSC-SPEC-E-0031	Cables, Electrical, Specification for
KSC-STD-132	Potting and Molding Electrical Cable Assembly Terminations, Standard for
KSC-STD-164	Environmental Test Methods for Ground Support Equipment, Standard for
KSC-STD-E-0021	KSC Telecommunication Premises Distribution Systems, Design of, Standard for

Military

MIL-DTL-915	Cable, Electrical, for Shipboard Use, General Specification for
MIL-DTL-17	Cables, Radio Frequency, Flexible and Semirigid, General Specification for
MIL-DTL-5015H	Connectors, Electrical, Circular Threaded, An Type, General Specification for
MIL-DTL-12000	Cable, Cord, and Wire, Electric; Packaging of
MIL-DTL-22992	Connectors, Plugs and Receptacles, Electrical, Waterproof, Quick Disconnect, Heavy Duty Type, General Specification for
MIL-DTL-26482	Connectors, Electrical, (Circular, Miniature, Quick Disconnect, Environment Resisting), Receptacles and Plugs, General Specification for
MIL-DTL-38999L	Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded, and Breech Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification for

MIL-DTL-38999L SUPP 1	Connectors, Electrical Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded and Breech Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification for
MIL-DTL-81381	Wire, Electric, Polyimide-Insulated, Copper or Copper Alloy
MIL-PRF-46846C	Rubber, Synthetic, Heat – Shrinkable, Performance Specification
MIL-STD-129	Military Marking for Shipment and Storage
MIL-STD-1560	Insert Arrangements for MIL-DTL-38999, MIL-DTL-27599 and MIL-C-29600 Series A Electrical Circular Connectors
MIL-STD-1651	Insert Arrangements For MIL-C-5015, MIL-C-22992 (Classes C, J, and R), and MIL-C-83723 (Series II) Electrical Connectors
MIL-STD-1669	Environment Resisting, Circular, Electrical Connectors
MIL-W-16878	Wire, Electrical, Insulated, General Specification for
QPL-5015-43	Connectors, Electrical, Circular Threaded, AN Type, General Specification for

National Aeronautics and Space Administration (NASA)

CxP 72274	Ground Systems: Electromagnetic Environmental Effects (E^3) Requirements Document
NASA-HDBK-1001	Terrestrial Environment (Climatic) Criteria Handbook for Use in Aerospace Vehicle Development
NASA-STD-8739.4	Crimping, Interconnecting Cables, Harnesses, and Wiring
NASA-STD-8739.5	Fiber Optic Terminations, Cable Assemblies, and Installation

2.2 Non-Governmental

Unless otherwise indicated, citations apply to the latest edition and all amendments published to that edition.

National Fire Protection Association (NFPA)

NFPA 70	National Electrical Code
NFPA 497	Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas

Society of Automotive Engineers (SAE) International

SAE AMS-DTL-23053	Insulation Sleeving, Electrical, Heat Shrinkable, General Specification for
SAE AMS-I-23053/2	Insulation Sleeving, Electrical, Heat Shrinkable, Polyvinyl Chloride, Flexible, Crosslinked and Non-Crosslinked

International Telecommunication Union-T (ITU-T)

ITU-T G.120	Transmission characteristics of national networks
ITU-T G.651	Characteristics of a 50/125 µm multimode graded index optical fibre cable
ITU-T G.652	Characteristics of a single-mode optical fibre and cable
ITU-T G.655	Characteristics of a non-zero dispersion shifted single-mode optical fibre cable

Telecommunications Industry Association (TIA)/Electronic Industries Alliance (EIA)

EIA/TIA-440	Fiber Optic Terminology
TIA/EIA-568-B	Commercial Building Telecommunications Cabling Standard

<u>Telecordia</u>

GR-20	Generic Requirements for Optical Fiber and Optical Fiber Cable
GR-409	Generic Requirements for Premises Fiber Optic Cable

3. BULK CABLE

3.1 General Requirements

For new designs, single-connector and multiconductor cables shall be in accordance with 120E3100001 or 120E3100002. Cables specified in 120E3100001 are for use in outdoor, rugged environments or in Class I, Division 2, hazardous locations and shall be rated Underwriters Laboratory (UL) type TC, ITC, PLTC, or equivalent. Refer to NFPA 70 for cables used in other hazardous areas such as Class I, Division 1. Cables specified in 120E3100002 are for use in indoor, light-duty environments and shall be rated UL type CMG or equivalent.

3.1.1 Characteristics

3.1.1.1 Performance Characteristics

Each cable shall have performance standards documentation. Specifications of data cables, such as Ethernet and coaxial, shall include data rates and impedances. Connectors and terminations shall be chosen to complement cable rates and reduce loss at connections.

3.1.1.2 Physical Characteristics

All cables shall conform to standards documentation and workmanship criteria stated in 3.1.2.5. Specifications shall include copper stranding, insulation materials and dimensions, quantity of conductors, and National Fire Protection Association (NFPA) ratings where applicable.

Environment and system design will determine insulation and jacket materials. The selection of cable used indoors in a controlled environment will depend on system requirements and the specification for insulation and jacket materials.

Areas at Launch Complex 39 (LC-39) that are not in an enclosed controlled room are categorized as Class I, Division 2, at a minimum. Some areas are categorized as Class I, Division 1. Hazardous areas are defined by NFPA 70. Check program drawings for exact locations. Cables used outside in the launch environment shall be UL-rated TC, PLTC, ITC, MC, MV, or MI at a minimum. See NFPA 70 for cabling requirements in Class I, Division 1, areas.

3.1.1.3 Maintainability

a. Cables and connectors shall be selected to meet the useful life of the system, without the need for additional maintenance during the specified life of the system.

b. Cables and connectors that are not expected to meet the useful life of the system shall be identified as limited-life items.

c. Limited-life cables and connectors require periodic replacement or refurbishment, which must be defined in design and maintenance documents.

d. Connectors and terminations shall be such that maintenance does not require dismantling key components of the system.

e. Mean time to repair (MTTR) and downtime for preventive maintenance shall comply with program/project-specific requirements.

3.1.1.4 Environmental Conditions

3.1.1.4.1 Indoor Controlled Environment

An indoor controlled environment is any enclosed room that is protected from the outdoor environment and temperature-controlled.

A plenum is a compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system. The plenum is the space that allows air to circulate for heating and air-conditioning systems by providing pathways for either heated/conditioned or return airflows, as defined by NFPA 70. The space between the structural ceiling and the dropped ceiling or under a raised floor is typically considered a plenum and is depicted in Figure 1. However, some drop-ceiling designs create a tight seal that does not allow for airflow and therefore may not be considered a plenum air-handling space, as depicted in Figure 2.

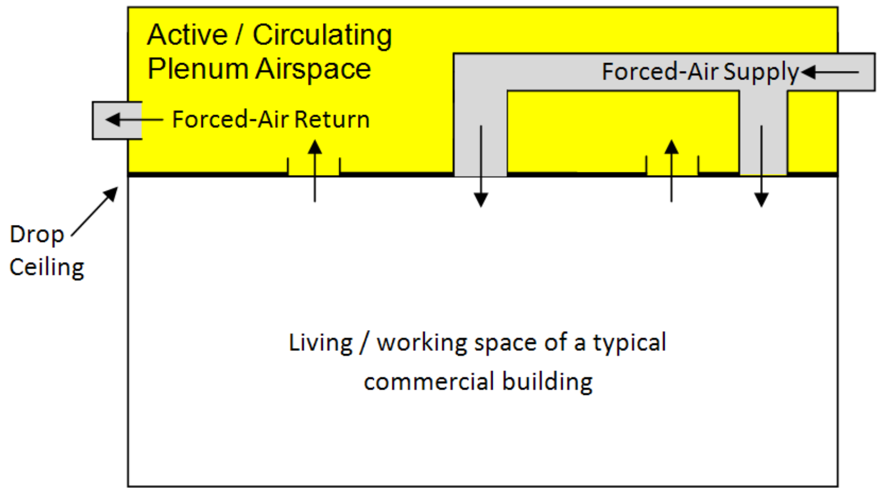


Figure 1. Building With a Plenum Airspace

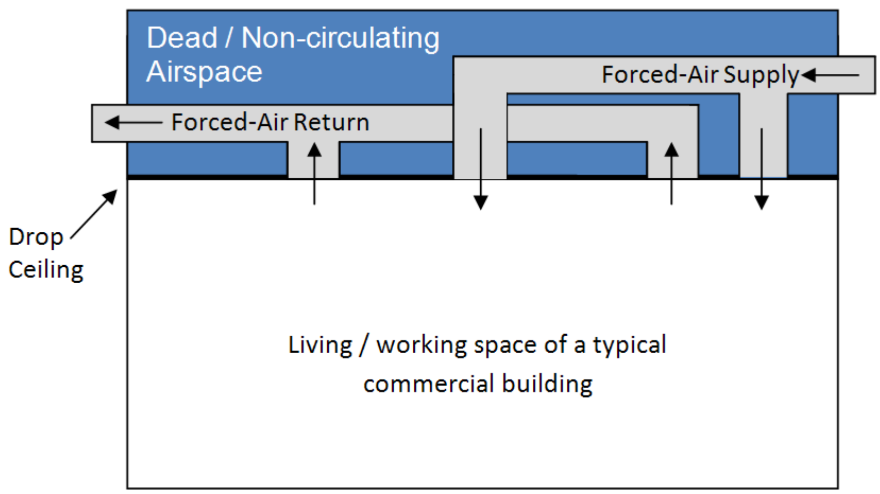


Figure 2. Building Without a Plenum Airspace

NFPA 70, Article 300.22, requires cables installed in plenum areas to be UL-rated and have jacket stamping showing that rating. Table 1 lists cable types allowed in plenums and other areas. Plenum-rated cables may be used in risers or general-purpose areas. Riser or general-purpose cables are not permitted for use in a plenum space. Openings created by any cable penetrations shall be sealed by appropriate fire-stopping material, to maintain the fire resistance rating of the fire partition.

Table 1. Cable Types Permitted in Plenum and Nonplenum Areas

NEC Article	Plenum	Riser	General-Purpose
336			TC
725	CL2P & CL3P	CL2R & CL3R	CL2, CL3 & PLTC
727			ITC
760	NPLFP & FPLP	NPLFR & FPLR	NPLF & FPL
770	OFNP & OFCP	OFNR & OFCR	OFN & OFC
800	CMP	CMR	CM & CMG
	MPP	MPR	MP
820	CATVP	CATVR	CATV

3.1.1.4.2 Outdoor Environment

The natural outside environment is defined by NASA-HDBK-1001. Cables and connectors located outside shall withstand the applicable natural environment. See Appendix B for environmental consideration for KSC.

3.1.1.4.3 Outdoor Launch Environment

A plume-induced environment occurs in outdoor launch locations. Ground support equipment (GSE) cables located in outdoor areas, such as LC-39, shall be designed to withstand intended launch environment. Conditions at LC-39 are defined by KSC-NE-8764. Outdoor areas include NFPA 70, Class I, Division 2, hazardous areas; and Groups B, C, and D, containing hydrogen, monomethylhydrazine (MMH), and propane, respectively. For more information on Class I, Division 2, groups, see NFPA 497.

3.1.1.4.4 Hazardous Locations

Locations where combustible liquids or flammable gases, vapors, or liquids are processed or handled, and where their release into the atmosphere could result in their ignition by electrical systems or equipment, are defined in NFPA 497. For proper selection of electrical equipment in hazardous (classified) locations, refer to NFPA 70.

3.1.1.5 Transportability

Cable put-ups heavier than 50 pounds (lb) shall be transported by cart. Detailed installation guidelines shall be provided within the installation design documents.

3.1.2 Design and Construction

3.1.2.1 Materials, Processes, and Parts

3.1.2.1.1 Cable Jacket

The recommended jacket material for outdoor-hazard-classified areas and rugged-use cables is thermoplastic chlorinated polyethylene (CPE). Polyvinyl chloride (PVC)-jacketed cables are allowed everywhere else. The availability and cost of PVC-jacketed cables make this material the preferred jacket for use in nonhazardous locations. Other materials may be used as directed in the specifications and should adhere to National Electrical Code (NEC) ratings. See Appendix C for a list of common jacket materials and its characteristics.

3.1.2.1.2 Insulation

The recommended insulation for outdoor and rugged-use cables is cross-linked polyethylene (XLPE). Other materials may be used as directed in the specifications and should adhere to NEC ratings. See Appendix C for a list of common insulation materials and its characteristics.

3.1.2.2 Electromagnetic-Environment Effects and Compatibility

Cable assemblies shall be designed to operate nominally within their applicable operating electromagnetic environment. Cable assemblies used for Constellation Ground Systems shall be designed and fabricated to meet requirements defined in CxP 72274, as specified in KSC-E-165 and Sections 3.2 and 3.3 of this handbook, except when an analysis shows that the cable does not pose (1) an electromagnetic risk to any other subsystem as a result of insufficient physical separation from a potentially susceptible system or item or (2) a risk to the system it is part of because of susceptibility to the electromagnetic environment.

3.1.2.3 Name Plates and Product Marking

Cables shall be identified by a printed marking applied to the outer surface of the jacket.

3.1.2.3.1 Cable Identification

The cable identification marking applied to the outer surface of the sheath shall consist of the following:

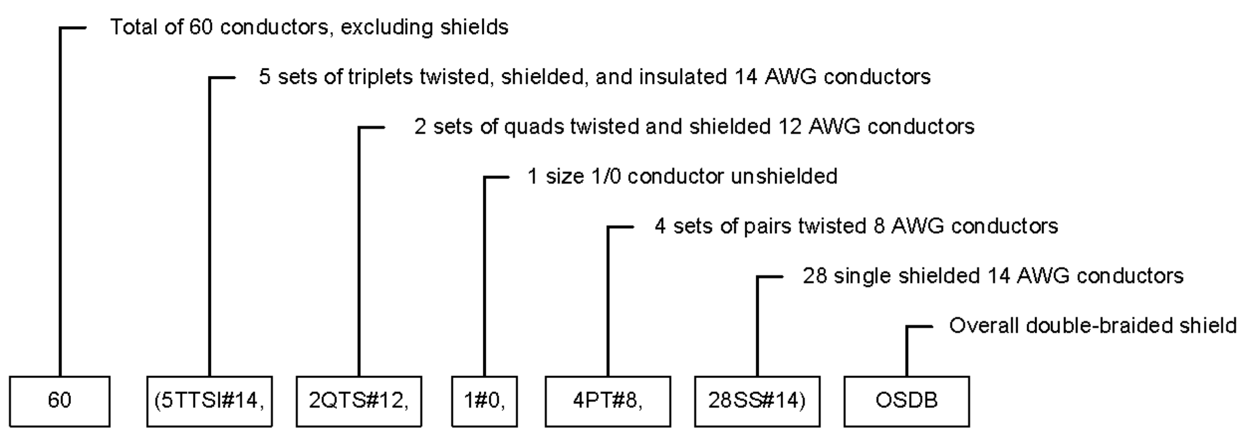
a. KSC specification sheet number or other standard specification,

b. cable type designation (see 3.1.2.3.2), and

c. manufacturer's name or code and the year manufactured.

3.1.2.3.2 Cable Type Designation Method

EXAMPLE: 60(5TTSI#14, 2QTS#12, 1#0, 4PT#8, 28SS#14)OSDB



No symbol for unshielded conductor. All conductors are considered to be insulated.

No symbol for standard neoprene sheath with no overall shield or other covering.

Abbreviations used in cable type designations:

MI	mineral-insulated cable (solid copper tubing shield)
OS	overall braided shield
OSDB	overall double-braided shield
PT	two conductors twisted
PTS	two conductors twisted and shielded
PTSI	two conductors twisted, shielded, and insulated
QT	four conductors twisted
QTS	four conductors twisted and shielded
QTSI	four conductors twisted, shielded, and insulated
SH	shield
SO	service with oil-resistant jacket

SPC	silver-plated copper
SS	single-conductor shielded
TC	tinned copper
TCSH	tinned-copper shield
TFE	extended polytetrafluoroethylene
TT	three conductors twisted
TTS	three conductors twisted and shielded
TTSI	three conductors twisted, shielded, and insulated
5	use number in this position for five or more conductors

3.1.2.4 Cabling and Wiring Guidelines

For complete wiring and installation requirements, see KSC-E-166.

a. All cables and wiring shall be clamped and supported to remain clear of sharp edges and moving parts.

b. All cables and wiring shall be clamped and supported to eliminate mechanical stress on wires, terminations, and connectors.

c. All cables and wiring shall be marked to clearly indicate the correct mating connecting or termination point to preclude phase reversal or cross-connection.

d. All alternating-current (AC) power cables shall have an independent, non-current-carrying ground conductor.

e. All electrical/electronic wiring shall be located and clamped to eliminate any possibility of contact with lines containing liquid.

f. Electrical wiring or cabling shall not be bundled with fluid system lines or hoses.

g. Electrical/electronic components and wiring shall be installed above fluid system lines to minimize exposure to leaking fluids.

h. High-voltage wiring or power cables shall not be routed near voltage-sensitive equipment or high-temperature sources.

i. All terminals, insulators, sleeves, identifiers, and decals shall be of material compatible with solvent, oil mixture, other reactive fluids, and heat in the operating environment.

j. To prevent unwanted noise coupling, whenever possible, power cables and signal cables shall not be grouped in the same bundle or cable tray.

3.1.2.5 Workmanship

The workmanship of completed cables inspected and tested as specified herein shall meet all requirements of their specification, the cable specification sheets, and other cited documents. NASA-STD-8739.4 may be cited where engineering documentation is not provided. All cables shall be manufactured and processed in such a manner as to be uniform in quality and shall be free of any burrs, die marks, chatter marks, foreign material, and other defects that will affect life, serviceability, or appearance.

3.1.2.6 Interchangeability

Cables are designed with preference for commercial off-the-shelf (COTS) parts and industry-accepted specifications and standards. A cable can be replaced by citing its cable assembly drawing.

3.1.2.7 Safety

Practical safeguarding is covered by the NFPA 70. The purpose of the code is the practical safeguarding of people and property from hazards arising from the use of electricity. The NEC covers the installation of electrical conductors, equipment, and raceways; signaling and communications conductors, equipment, and raceways; and optical-fiber cables and raceways. Further safety requirements may be listed in cable specifications. Applications requiring design or construction not adhering to the NEC shall require a waiver from the Authority Having Jurisdiction (AHJ) at KSC.

3.1.3 Fabrication

Cables may cite current industry standards and specifications or may be fabricated according to120E3100003 or 79K19600 for legacy systems. 79K19600 is not recommended for new designs. Appendix D explains how to create a cable subassembly drawing. Cables intended for use in hazardous locations or harsh environments shall be terminated in a way that protects them from the environment. Connectors potted and molded as specified in KSC-STD-132 meet this criterion. Other methods of environmental protection are available and must meet requirements in KSC-STD-164.

3.1.4 Testing After Assembly

Cable and harness assemblies shall meet testing and inspection requirements in NASA-STD-8739.4, Section 18.

3.2 Single and Multiple Straight Conductors

3.2.1 Performance Characteristics

Cables shall meet performance characteristics according to their specifications and standard documentation.

3.2.2 Physical Characteristics

Dimensions and overall physical characteristics shall be outlined in the cited documentation. Cables for new KSC designs shall cite 120E3100001 and 120E3100002. Existing cables may continue to cite KSC-SPEC-E-0024 and KSC-SPEC-E-0031.

3.2.3 Overall Shielding

This section includes recommended and best practices for shielding and shield termination. Ultimate design should be based on the system requirements and environment. This overall shielding method is recommended for signal and instrumentation applications.

Multiconductor cable should include an overall shield to guard the conductors from harmful electromagnetic interference (EMI). Coverage should be maximized for any aperture provides a path for EMI to penetrate to the interior of the cable. An appropriately folded-foil outer shield should be used to provide nearly 100 percent coverage. Also, an overall copper braid should be added to make the cable more rugged and increase current capacity, while further improving shielding performance.

Overall foil/braid shields should be terminated 360 degrees (°) to the backshell of each connector to close any potential apertures at the terminations. Pigtails or drain wires connected to the overall shield should never enter an enclosure. The shielded “barbell” approach should be used to effectively encapsulate the circuit (Figure 3). This includes 360° terminations at any intermediate breakpoint connections (e.g., terminal distributors and bulkhead plates).

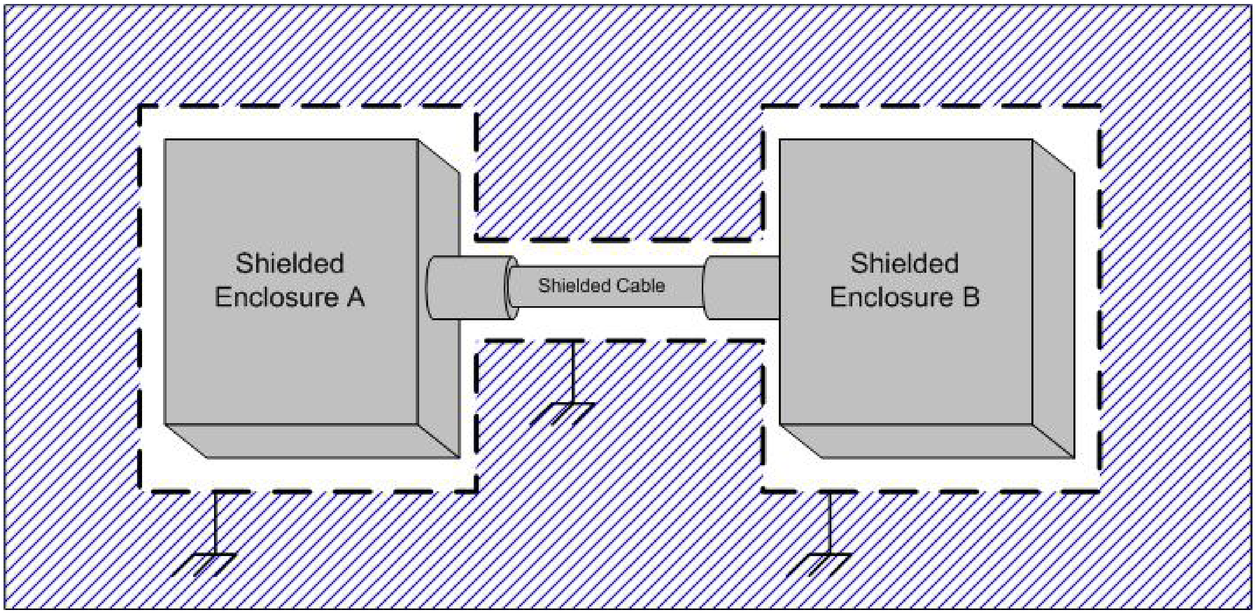


Figure 3. Shielded "Barbell"

3.3 Twisted-Pair Cable

3.3.1 Characteristics

Twisted-pair cabling is a form of wiring in which two conductors are wound together for the purpose of canceling out EMI from external sources. This section does not include information on category cable. Category cable is discussed in 3.4.

3.3.1.1 Performance Characteristics

Performance requirements can be stated in the system design documentation or in cited documentation.

3.3.1.2 Physical Characteristics

Twist rates (usually defined in twists per meter) will be specified in cited documentation. Proprietary methods of twists and cable construction may be used to increase data rates and reduce noise interference.

3.3.1.3 Shielding

This section includes recommended and best practices for shielding and shield termination. Ultimate design should be based on system requirements and environment.

3.3.1.3.1 Overall Shielding

See 3.2.3.

3.3.1.3.2 Conductor Arrangement

To guard against harmful coupling of magnetic fields, the conductors should be appropriately grouped and twisted (Figure 4). This might include twisted pairs, triplets, or quadruplets.

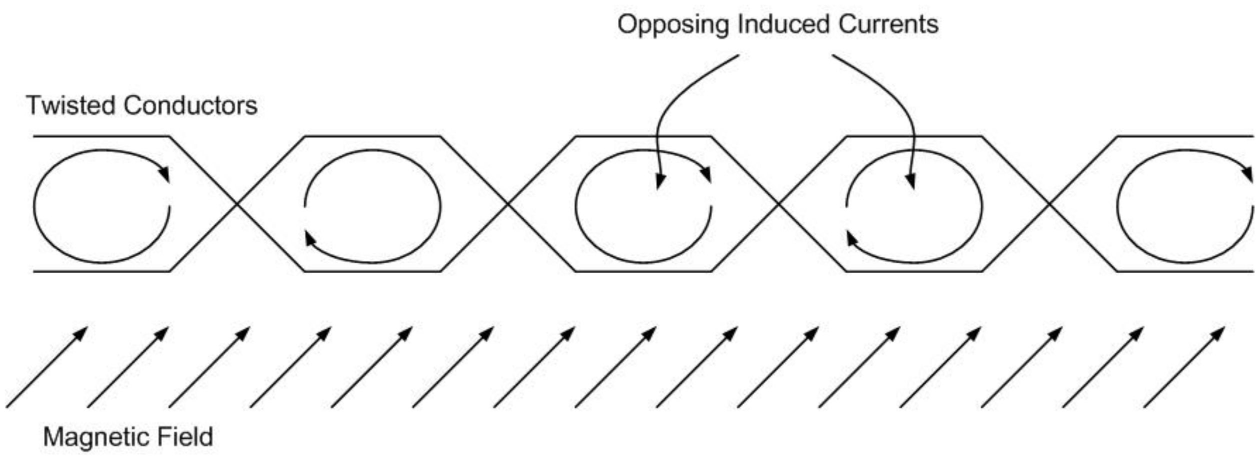


Figure 4. Twisted Conductor

3.3.1.3.3 Internal Shields

Multiconductor cable should also include isolated and folded-foil shields around each twisted conductor grouping (pair/triplet/quad) to reduce any potential for crosstalk coupling from a neighbor grouping within the same cable. This harmful crosstalk may occur under normal operations or be experienced under anomalous conditions. In addition to minimizing crosstalk, this internal shield provides an added layer of protection that guards against noise leaking through the outer shield. The internal shield also minimizes the effects of ground currents that are likely present on that outer shield.

To minimize current on the internal shields, the internal shields should be terminated to facility ground at one end only (Figure 5). Typically this single-point termination exists at the source enclosure. Depending on the circuit, bonding may take place either inside the enclosure or inside the connector mated to the enclosure. Because a 360° bonding of the internal shields may be difficult, drain wires can be used for terminating these shields. Individual drain wires should be included with each twisted-conductor grouping inside the internal foil shields. To maintain the single-point ground, where necessary the drain wires for each internal foil shield should pass through the connector on a single dedicated pin or may be combined with one or several pins.

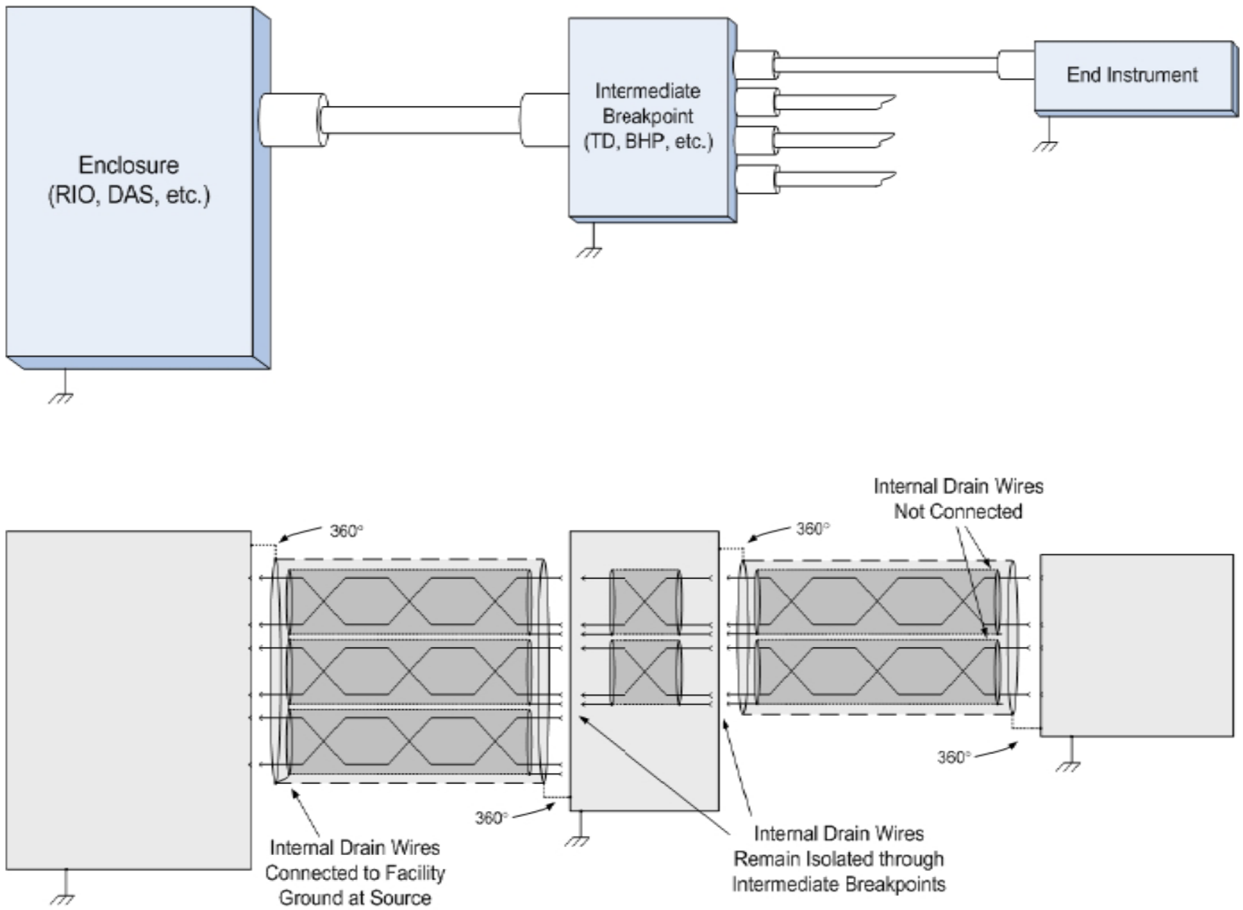


Figure 5. Recommended Shield Terminations

3.3.2 Design and Construction: Color Codes

Insulator colors are determined by design and system requirements. Telephone cables typically follow the color codes in Table 2. The ICEA/NEMA Paired Color Code, Table 3, is a coding whereby one wire of all pairs is coded white and its mate is coded in accordance with the first 21 conductors of the ICEA/NEMA Method 1, omitting white and repeating the sequence as necessary.

Table 2. Telephone Wire Color Code

<table>
<tr><th>Pair #</th><th>First Wire</th><th>Second Wire</th><th>Pair #</th><th>First Wire</th><th>Second Wire</th></tr>
<tr><td>1</td><td rowspan="5">White</td><td>Blue</td><td>16</td><td rowspan="5">Yellow</td><td>Blue</td></tr>
<tr><td>2</td><td>Orange</td><td>17</td><td>Orange</td></tr>
<tr><td>3</td><td>Green</td><td>18</td><td>Green</td></tr>
<tr><td>4</td><td>Brown</td><td>19</td><td>Brown</td></tr>
<tr><td>5</td><td>Slate</td><td>20</td><td>Slate</td></tr>
<tr><td>6</td><td rowspan="5">Red</td><td>Blue</td><td>21</td><td rowspan="5">Violet</td><td>Blue</td></tr>
<tr><td>7</td><td>Orange</td><td>22</td><td>Orange</td></tr>
<tr><td>8</td><td>Green</td><td>23</td><td>Green</td></tr>
<tr><td>9</td><td>Brown</td><td>24</td><td>Brown</td></tr>
<tr><td>10</td><td>Slate</td><td>25</td><td>Slate</td></tr>
<tr><td>11</td><td rowspan="5">Black</td><td>Blue</td><td></td><td></td><td></td></tr>
<tr><td>12</td><td>Orange</td><td></td><td></td><td></td></tr>
<tr><td>13</td><td>Green</td><td></td><td></td><td></td></tr>
<tr><td>14</td><td>Brown</td><td></td><td></td><td></td></tr>
<tr><td>15</td><td>Slate</td><td></td><td></td><td></td></tr>
</table>

Table 3. ICEA Paired-Wire Color Code

<table>
<tr><th>Pair #</th><th>First Wire</th><th>First Wire Tracer</th><th>Second Wire</th><th>Pair #</th><th>First Wire</th><th>First Wire Tracer</th><th>Second Wire</th></tr>
<tr><td>1</td><td>Black</td><td rowspan="5"></td><td rowspan="11">White</td><td>12</td><td>Red</td><td rowspan="3">White</td><td rowspan="10">White</td></tr>
<tr><td>2</td><td>Red</td><td>13</td><td>Green</td></tr>
<tr><td>3</td><td>Green</td><td>14</td><td>Blue</td></tr>
<tr><td>4</td><td>Orange</td><td>15</td><td>Black</td><td rowspan="4">Red</td></tr>
<tr><td>5</td><td>Blue</td><td>16</td><td>White</td></tr>
<tr><td>6</td><td>White</td><td rowspan="5">Black</td><td>17</td><td>Orange</td></tr>
<tr><td>7</td><td>Red</td><td>18</td><td>Blue</td></tr>
<tr><td>8</td><td>Green</td><td>19</td><td>Red</td><td rowspan="2">Green</td></tr>
<tr><td>9</td><td>Orange</td><td>20</td><td>Orange</td></tr>
<tr><td>10</td><td>Blue</td><td>21</td><td>Black</td><td></td></tr>
<tr><td>11</td><td>Black</td><td>White</td><td></td><td></td><td></td><td></td></tr>
</table>

3.4 Category Cable

Category 5e, or Cat 5e, is the current industry standard for computer networks such as Ethernet. In developing plans for future designs and particularly those with higher data rates, Cat 6 or Cat 6a cables should be considered. For further information on communication systems and cabling, see KSC-STD-E-0021.

3.4.1 Characteristics

The twisted pair cable type is designed for high signal integrity. For detailed physical and performance characteristics, refer to TIA/EIA-568-B.

3.4.1.1 Performance Characteristics

General performance characteristics are listed in Table 4.

Table 4. Performance Characteristics for Category Cables

Cable	Performance	Maximum Length	
		m	ft
Cat 5e	<100 MHz	100	328.08
Cat 6	<250 MHz	100	328.08
Cat 6a	<500 MHz	100	328.08

3.4.1.2 Physical Characteristics

Refer to TIA/EIA-568-B.

3.4.1.3 Shielding

Category cables do not typically require shielding. An overall shield and internal shields may be specified in documentation for procurement. Standard category cables that include shielding are Cat 6 screened twisted-pair (ScTP) cables and shielded twisted-pair (STP-A) cables (TIA/EIA-568-B.2).

3.4.2 Design and Construction

Refer to TIA/EIA-568-B.

3.4.2.1 Color Codes

The color coding shall be as shown in Table 5.

Table 5. Color Codes for Four-Pair Horizontal Cables

Conductor Identification	Color Code	Abbreviation
Pair 1	White-Blue Blue	(W-BL) (BL)
Pair 2	White-Orange Orange	(W-O) (O)
Pair 3	White-Green Green	(W-G) (G)
Pair 4	White-Brown Brown	(W-BR) (BR)

3.4.2.2 100-Ohm Balanced Twisted-Pair Telecommunications Outlet/Connector

The pin/pair assignments recommended to accommodate certain eight-pin cabling systems are shown in Figure 6. Optional pin/pair assignments are shown in Figure 7. These illustrations depict the front view of the telecommunications outlet/connector.

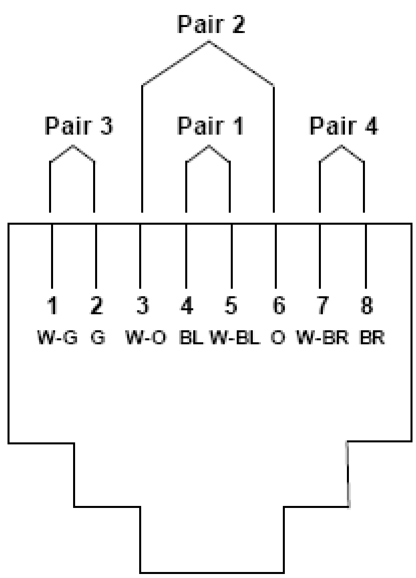


Figure 6. Recommended Eight-Position Jack Pin/Pair Assignments (T568A)

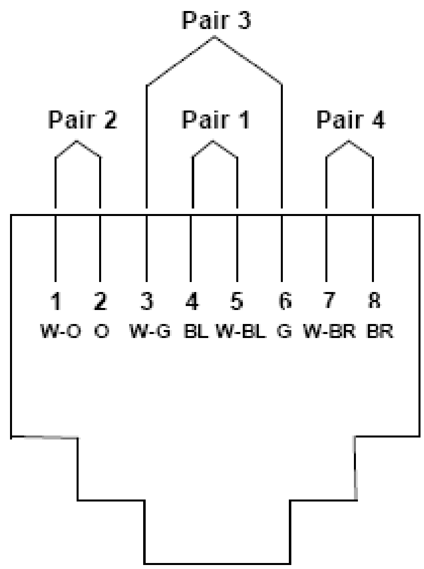


Figure 7. Optional Eight-Position Jack Pin/Pair Assignment (T568B)

3.4.2.3 Materials, Processes, and Parts

The standardization of category cables has produced a variety of COTS products in accordance with TIA/EIA-568-B. COTS products may be used with the appropriate NEC rating.

3.4.2.4 Workmanship

Refer to TIA/EIA-568-B.

3.5 Coaxial Cable

Coaxial or radio frequency (RF) cable may reference MIL-DTL-17. Communications networks offer requirements for special-use coaxial cable. The design may require a reference to the recognized industry standard.

3.5.1 Characteristics

Coaxial cables are flexible and semirigid cables with solid and semisolid dielectric cores, with single, dual, and twin inner conductors. Coaxial cables are primarily intended for use as transmission lines to conduct energy in a simple power transfer continuously or intermittently. In general, these cables are designed for low-loss, stable operation from the relatively low frequencies through the higher frequencies in the microwave and radar regions of the frequency spectrum.

3.5.1.1 Cable Types

3.5.1.1.1 Flexible, Coaxial, Single-Conductor Cables

A flexible coaxial cable shall be constructed of a single inner conductor covered by a flexible, low-loss, RF dielectric core material, which shall then be surrounded by one or more braided outer conductors, with the whole assembly encased in a protective covering. In some cases, this is covered by an extra braided armor for use in extremely abusive applications. Each element of the cable is designed to contribute to the requirements of the finished product.

3.5.1.1.2 Semirigid, Coaxial, Single-Conductor Cables

Semirigid coaxial cables shall be constructed of a single inner conductor covered by a flexible, low-loss, RF dielectric core material, which is then surrounded by a solid, continuous, metallic outer conductor.

3.5.1.1.3 Two-Conductor Cables

Individual dielectric cores of two-conductor cables shall meet the requirements of solid or semi-solid dielectric cores. One strand of one of the inner conductors shall be coded for identification and shall be visible without disturbing the stranding. That is, if all of the strands of the inner conductors are coated, then one strand is to be bare; or if all of the strands are bare, then one strand is to be coated.

3.5.1.1.3.1 Twin Cables

Twin cables shall be constructed of individual inner conductors within individual dielectric cores within a common outer conductor, or may have individual inner conductors within a common outer core that may be filled-to-round.

3.5.1.1.3.2 Dual Cables

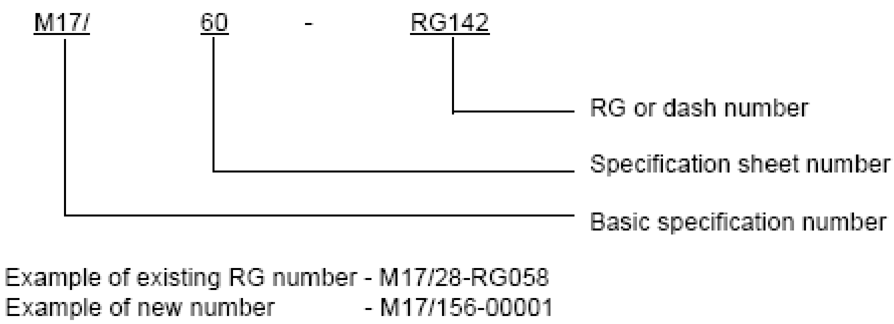
A dual cable shall be constructed of individual coaxial cables enclosed within a common outer conductor.

3.5.1.1.4 Triaxial Cables

Triaxial cables shall be constructed the same as regular coaxial cables, except for an additional interlayer of dielectric material over the outer conductor, over which is laid an extra shield, with the whole assembly encased in a protective covering.

3.5.1.2 M17 Part Identification Number (PIN)

The PIN consists of the letter “M” followed by the specification number, the associated slash sheet number and the sequentially assigned dash number or “RG” number, as shown below.



3.5.1.3 MIL-DTL-17 Coaxial Cables

See Appendix E for a table of available MIL-DTL-17 coaxial cables and major characteristics.

3.6 Fiber-Optical Cables

3.6.1 Definitions

Common definitions for fiber-optical terminations, cable assemblies, and installation can be found in Appendix F. Related terms and definitions can be found in EIA/TIA-440.

3.6.2 Physical Characteristics

Figure 8 depicts a fiber-optical cable prepared for termination.

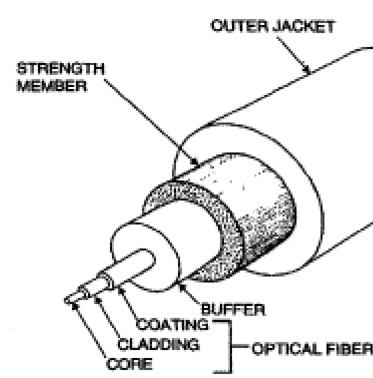


Figure 8. Parts of a Typical Fiber-Optical Cable

3.6.3 Design and Construction

3.6.3.1 General

Fiber-optical cable assemblies, installations, and terminations shall be in accordance with NASA-STD-8739.5.

3.6.3.1.1 Underground Fiber-Optical Cable

Fiber-optical cable for underground cable ducts or direct-bury application shall be in accordance with Telecordia GR-20.

3.6.3.1.2 Intrabuilding Fiber-Optical Cable

Fiber-optical cable for intrabuilding premise application shall be in accordance with Telecordia GR-409.

3.6.3.1.3 Single-Mode Fiber-Optical Cable

For transmission of signals up to 10 gigabits (Gb), single-mode fiber-optical application shall be in accordance with ITU-T G.652. For transmission of signals greater than 10 Gb, single-mode fiber-optical application shall be in accordance with ITU-T G.655.

3.6.3.1.4 Multimode Fiber-Optical Cable

Multimode fiber-optical application shall be in accordance with ITU-T G.651.

3.6.3.2 Cable Assembly

Fiber-optical cables shall be prepared for connector assembly in accordance with the procedures established in NASA-STD-8739.5, Chapter 7.

Fiber-optical cables shall be identified in such a way to distinguish these cables from wire or coaxial cables.

Cable connectors shall be permanently marked with a mating connector designation within 15 centimeters (cm) (6 inches [in]) of the connector body, or as stated in the engineering documentation.

The following verification and inspection provisions apply.

a. At a minimum, prior to assembly, prepared fiber-optical cables shall be subject to documented in-process peer verification for the following:

   (1) correct cable stripping dimensions,

(2) strength member damage,

(3) cracks, nicks, cuts, or other damage in the termination area to all cable components, including the optical fiber,

(4) chemical strip wicking or damage, and

(5) cleanliness according to of NASA-STD-8739.5, Chapter 8.

b. Prior to assembly, prepared fiber-optical connector parts shall be examined for the following:

(1) blockage in the internal fiber channel (the prepared fiber shall not be used to check for blockage),

(2) cleanliness according to NASA-STD-8739.5, Chapter 8, and

(3) cracks or deformities on the connector ferrule.

c. Prior to assembly, verification of other requirements (e.g., heat-shrinkable-sleeving dimensions or crimp sleeve requirements) shall be in accordance with engineering documentation.

d. Completed cable assemblies shall be inspected for the following:

(1) The strength member, when visible, is uniformly distributed and securely attached to the connector.

(2) Heat-shrinkable sleeving and/or crimp sleeves are positioned properly.

(3) The connector endface geometry complies with engineering documentation.

(4) The connector ferrule length complies with engineering documentation.

(5) The connector endface requirements comply with Appendix G or the engineering documentation.

(6) The strain relief device is positioned and attached as specified in the engineering documentation.

(7) Cleanliness conforms toNASA-STD-8739.5, Chapter 8.

(8) The cable axial alignment with the connector is within 5 cm (2 in) of the termination or as specified in the engineering documentation.

(9) There are no nicks exposing underlying elements.

(10) There are no kinks or twists.

(11) Cable designations are properly marked.

If cracks in a flight fiber-optical cable endface are found, the cable shall be reterminated or scrapped. Repolishing to fix cracks in flight hardware is prohibited.

3.6.3.3 Testing After Assembly

All completed cable assemblies shall be tested to ensure that measured optical performance (e.g., insertion loss or return loss) meets or exceeds the performance requirements in the engineering documentation. Records of testing shall be maintained with the assembly or subassembly documentation.

Upon completion of the tests required in 3.6.3.2.d, the cable assemblies shall be subjected to workmanship temperature cycling or preconditioning as identified in the engineering documentation.

The cable assembly shall be retested and examined for the following:

a. cracks in fiber endface using both normal lighting and back lighting: The fiber-optical cable assembly shall be back-lit using a noncoherent, low-intensity light source from the opposite end of the cable, without touching the fiber as part of the examination,

b. pistoning of the fiber in the connector,

c. cracks in the epoxy bond line at the endface, and

d. shrinkage of the outer jacket: Other cable components shall also be evaluated for shrinkage. An unacceptable amount of shrinkage after temperature cycling shall be defined by an excessive optical-loss value, as specified in the engineering documentation.

3.6.3.4 Design Considerations

a. The connector should be of the construction, weight, and physical dimensions specified by engineering requirements.

b. The design should provide cable stress relief and environmental sealing between the cables and connector to prevent the entry of contaminants. The stress relief and connector/cable attachment method should provide protection from both cable tensile forces and cable axial compressive forces.

c. The design should meet the requirements for optical, mechanical, and environmental performance as specified by engineering requirements.

d. All connector parts of the same type should be physically and functionally interchangeable, without the need to modify such items or the termination equipment. A complete mated-connector design should consist only of parts from the same manufacturer to ensure that connectors mate properly.

e. When dissimilar metals are used in contact with each other, protection against electrolysis and corrosion should be provided. Metal spraying or metal plating of dissimilar base metals to provide similar or suitable abutting surfaces is permitted.

f. Seals should provide isolation from humidity and/or contamination for connector interior parts.

g. The maximum allowable connector coupling loss should be specified in the engineering documentation.

h. The connector mate durability should be addressed in the engineering documentation.

i. Staking and torque values should be defined in the engineering documentation.

j. Minimum distance for cable bend radius should be defined in the engineering documentation.

k. For inspection purposes, clear, heat-shrinkable sleeving is recommended.

3.6.3.5 Materials, Processes, and Parts

All material shall be selected to conform to the project contamination control plan and shall be compatible with both the termination process and the environment in which the finished product will be used.

Exterior parts shall be corrosion-resistant. The use of cadmium plating is prohibited.

Materials shall have no adverse effects on the health of personnel during handling and when used for the intended purpose.

Fire-rated fiber-optical cables are available for use for specific applications when required.

4. CONNECTORS

4.1 Guidelines

A variety of circular environmental connectors are used at KSC. Application and environment determine shell style and connector type. Military-series connectors are recommended for harsh and outdoor environments. Table 6 lists the characteristics of four basic families of connectors that support KSC GSE requirements. MIL-DTL-26482 connectors have been widely used at KSC but are no longer recommended for new design because of the bayonet-type coupling.

Table 6. Typical Connectors Used at KSC

Attribute	MIL-DTL-38999 Series III	MIL-DTL-5015	MIL-DTL-22992	MIL-DTL-26482
Harsh Environment	X	X	X	X
Wire Gauge Range AWG	28 to 12	26 to 0	16 to 4/0	24 to 12
Number of Circuits	3 to 128	1 to 85	1 to 104	1 to 61
Sealed Against Water Jets	Yes	Yes	Yes	Yes
EMI/RFI Shielding	Yes	Yes	Yes	Yes
Style	Circular	Circular	Circular	Circular
Operating Voltage/ DWV	2,300 VAC	1,750/3,000 VAC	3,000	1,000/2,300 VAC
Current Rating (A)	1.5 to 23	150/245	40 to 200	23
Power & Signal in Same Layout	Yes	Yes	Yes	Yes
Operating Temperature	–65 °C to 200 °C –85 °F to 392 °F	–55 °C to 125 °C –67 °F to 257 °F	–55 °C to 125 °C –67 °F to 257 °F	–55 °C to 200 °C 67 °F to 392 °F
Submersible	Yes	Yes	Yes	Yes
Individual Wire Sealing	Yes	Yes	Yes	Yes
Cable Jacket Sealing	Yes	Yes	Yes	Yes
Type of Coupling	Racheting Threaded	Threaded	Threaded	Bayonet
Life in Mating Cycles (minimum)	500	100	500	500
Shock Test (g's)	300	50		150
Vibration Test (g_{rms})	60	15		20
Susceptibility to Damage	Extra Low	Very Low	Very Low	Very Low
Shell Material	Aluminum Alloy, Stainless Steel, or Composite	Aluminum Alloy	Aluminum Alloy	Aluminum Alloy
Shell Plating	Cadmium, Electroless Nickel, or Marine Nickel Aluminum Bronze	Cadmium, Anodized; Electroless Nickel; or Black Zinc Cobalt	Cadmium over Nickel, or Black Anodized	Cadmium, Anodized; Electroless Nickel; or Zinc Cobalt
Shell Color	Olive Drab, Silver, or Bronze	Olive Drab, Silver or Black	Olive Drab	Olive Drab, Silver, or Black
Positive Shell Polarization	Yes	Yes	Yes	Yes
Insert Polarization Options	Yes	Yes	Yes	Yes
User Polarization	No	No	No	No
Contact Plating	Gold	Silver or Gold	Silver or Gold	Gold
Contact Styles				
Crimp	X	X	X	X
Solder		X	X	X

Attribute	MIL-DTL-38999 Series III	MIL-DTL-5015	MIL-DTL-22992	MIL-DTL-26482
Printed Circuit Solder	X	X		X
Printed Circuit Press Fit				
Thermocouple	X	X	X	X
Wire Wrap				
Coaxial	X	X	X	X
Insulation Displacement				
Preterminated				
Fiber-Optical	X			X
High-Voltage		X	X	X
First-Mate Last-Break		X		

The following general guidelines apply.

a. All circular connectors for use in harsh, outdoor applications shall be potted and molded as specified in KSC-E-165.

b. Jam-nut-style connectors are recommended for use in pressurized cabinets or boxes.

c. Gaskets are available to mitigate galvanic reaction from dissimilar metals and may also be used to seal gaps when using wall or box-mount receptacles.

d. Connectors with unkeyed symmetrical pin arrangements shall not be used.

e. All ground equipment cables that connect to prototype or critical hardware shall have connectors which are individually keyed, sized, or shaped, making them compatible with the mating receptacle.

f. Connectors shall be sized to prevent improper connection or shall be marked with a reference designator system to indicate proper connection.

g. Miniature quick-disconnect connectors shall not be used in areas subject to water intrusion.

h. Connectors subject to frequent disconnection and connectors that are exposed to harmful environments when they are disconnected shall have attached caps, plugs, or covers to protect the connectors from damage or contamination while unmated.

i. Connectors, cabling, and wiring shall be located so they can be connected and disconnected without damaging the connector ring, abrading or stressing the cable, or injuring the personnel performing the work. Where required, sufficient space shall be provided to allow strap or spanner wrenches to be used, without damaging adjacent cabling or components.

4.2 Copper Connectors

4.2.1 MIL-DTL-38999 Connectors

4.2.1.1 Characteristics

MIL-DTL-38999L covers four series of miniature, high-density, bayonet, threaded, or breech coupling, circular, environment-resistant, electrical connectors that use removable-crimp or fixed hermetic solder contacts, and are capable of operation within a temperature range of –65 degrees Celsius (°C) to +200 °C (–85 degrees Fahrenheit [°F] to +392 °F).

All series include rear-release, removable pin and socket contacts with crimp termination. All series are designed to ensure proper orientation of the mating halves prior to electrical-circuit closure. All series include hermetically sealed receptacles with fixed contacts for solder termination. All series include EMI shielding capability. Series I, III, and IV connectors with conductive finishes provide electrical continuity between mated shells prior to contact engagement and have the contacts so located as to be protected from handling damage and inadvertent electrical contact. Series II provides a low silhouette for minimum size and weight and includes connectors that provide shell-to-shell electrical continuity when mated.

4.2.1.2 Series

Series III, triple-start, self-locking, threaded-coupling connectors are recommended for new designs in GSE.

NOTE

Information included in this handbook will focus only on Series III.

Series I and II have bayonet-style couplings, which are not recommended for new designs. Series IV breech-coupling-style connectors are commonly used for space applications.

The Series I, II, III, and IV connectors are not interchangeable or intermateable.

I Scoop-proof, bayonet coupling (inch-pound dimensions and measurements).

II Non-scoop-proof, bayonet coupling, low silhouette (inch-pound dimensions and measurements).

III Scoop-proof, triple start, self-locking, threaded coupling (metric dimensions and measurements).

IV Scoop-proof, breech coupling (metric dimensions and measurements).

4.2.1.3 Part Identification Number (PIN)

PINs are used to identify connectors and to simplify the ordering process. The following is an example of a Series III PIN:

D38999/26	W	D	19	P	N
Specification sheet number (4.2.1.4)	Class (4.2.1.5)	Shell size number (4.2.1.6)	Insert arrangement (4.2.1.7)	Contact style (4.2.1.8)	Polarization (4.2.1.9)

4.2.1.4 Specification Sheet Number

MIL-DTL-38999L, Supplement 1, contains a complete list of specification sheet numbers for all 38999 series connectors. Table 7 shows three standard receptacles for use in GSE.

Table 7. Common MIL-DTL-38999, Series III, Connectors Used in GSE at KSC

MIL-DTL-38999/20	MIL-DTL-38999/24	MIL-DTL-38999/26
		

4.2.1.5 Classes

Table 8 provides the shell materials and finishes for the classes of Series III connectors.

Table 8. Series III Shell Materials and Finishes

Class*	Class Description	Temperature Range	Intended Use	Material Description	Shell Material	Salt Fog (hr)	Shell-to-Shell Conductivity (mv)
F	Environment-resisting, conductive plating	–65 °C to +200 °C –85 °F to +392 °F	Provides a conductive shell for EMI requirements.	Electroless nickel	AL	48	1.0
J	Environment-resisting, conductive, corrosion-resistant composite	–65 °C to +175 °C –85 °F to +347 °F	Provides a corrosion resistant, lightweight, composite shell with conductivity equivalent to Class W.	Cadmium over nickel, olive drab	C	2000	3.0
K	Environment-resisting, corrosion-resistant steel with firewall barrier	–65 °C to +200 °C –85 °F to +392 °F	Provides a stainless-steel firewall connector for engine applications.	Passivate	SST	500	10.0
L	Environment-resisting, corrosion-resistant steel, electrodeposited nickel	–65 °C to +200 °C –85 °F to +392 °F	Provides a stainless-steel connector for general applications.	Electrodeposited nickel	SST	500	1.0
M	Environment-resisting, conductive, corrosion-resistant composite	–65 °C to +200 °C –85 °F to +392 °F	Provides a corrosion-resistant, lightweight, composite connector with conductive plating for EMI performance equivalent to Class F.	Electroless nickel	C	2000	3.0
N	Hermetically sealed, corrosion-resistant steel, electrodeposited nickel	–65 °C to +200 °C –85 °F to +392 °F		Electrodeposited nickel	SST	48	1.0
P	Environment-resisting, pure electrodeposited aluminum, conductive plating	–65 °C to +175 °C –85 °F to +347 °F	Applications requiring alternatives to cadmium plating.	Electrodeposited aluminum	AL	500	2.5
R	Same as Class F, but higher corrosion requirement	Same as F, but higher corrosion requirement	Applications requiring high corrosion resistance (for metallic shells).	Electroless nickel	AL	96	1.0
S	Environment-resisting with firewall barrier, corrosion-resistant steel, electrodeposited nickel	–65 °C to +200 °C –85 °F to +392 °F	Provides a stainless-steel firewall connector with enhanced EMI performance.	Electrodeposited nickel	SST	500	1.0
T	Environment-resisting, nickel fluorocarbon polymer, conductive plating	–65 °C to +175 °C –85 °F to +347 °F	Applications requiring alternatives to cadmium plating.	Nickel fluorocarbon polymer	AL	500	2.5
W	Environment-resisting, corrosion-resistant plating	–65 °C to +175 °C –85 °F to +347 °F	Provides a corrosion-resistant shell.	Cadmium over nickel, olive drab	AL	500	2.5
X	Same as Class W, but higher corrosion requirement	Same as W, but higher corrosion requirement	Applications requiring high corrosion resistance (for metallic shells).	Cadmium over nickel, olive drab	AL	1000	2.5
Y	Hermetically sealed, corrosion-resistant steel, passivated	–65 °C to +200 ° –85 °F to +392 °F C	Applications where pressure must be maintained.	Passivate	SST	500	10.0
Z	Environment-resisting, zinc nickel, conductive plating	–65 °C to +175 °C –85 °F to +347 °F	Applications requiring alternatives to cadmium plating.	Zinc nickel	AL	500	2.5

* All classes are electrically conductive.

4.2.1.6 Shell Size Number

PINs use code letters in place of shell sizes. See Table 9 for substitutions.

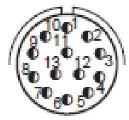
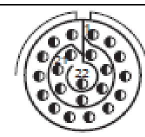
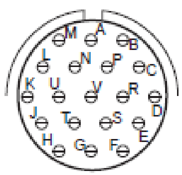
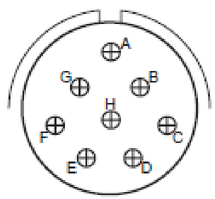
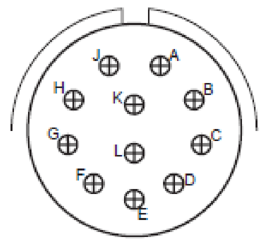
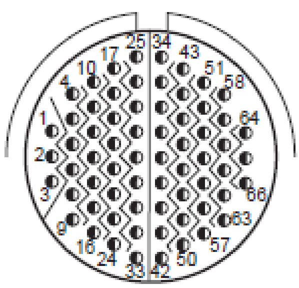
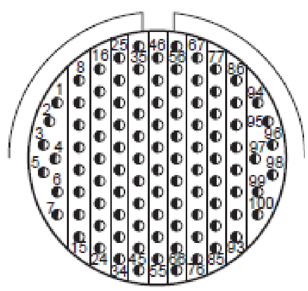
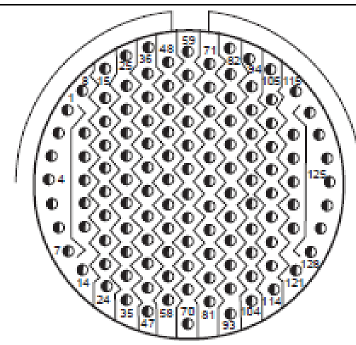
Table 9. Shell Size Code for Series III Part Numbering

Shell Size	Code Letter	Shell Size	Code Letter	Shell Size	Code Letter
9	A	15	D	21	G
11	B	17	E	23	H
13	C	19	F	25	J

4.2.1.7 Insert Arrangements

See MIL-STD-1560 for all available insert arrangements. Table 10 specifies nine insert arrangements recommended for use at KSC.

Table 10. Commonly Used Insert Arrangements

			
Insert Arrangement (shell sz – arrg.)	9–35	11–35	13–35
Service Rating	M	M	M
No. of Contacts	6	13	22
Contact Size	22D	22D	22D
			
Insert Arrangement (shell sz – arrg.)	15–19	17–8	19–11
Service Rating	I	II	II
No. of Contacts	19	8	11
Contact Size	20	16	16
			
Insert Arrangement (shell sz – arrg.)	19–35	23–35	25–35
Service Rating	M	M	M
No. of Contacts	66	100	128
Contact Size	22D	22D	22D

4.2.1.8 Contact Styles

4.2.1.8.1 Connectors Supplied With Standard Contact Arrangements

Contact designators for connectors that use standard contact arrangements as specified in MIL-STD-1560 are as follows:

P: Pin –	including hermetics with solder cups, 500-cycle contact	C: Pin –	feedthrough
S: Socket –	including hermetics with solder cups, 500-cycle contact	D: Socket –	feedthrough
H: Pin –	1,500-cycle contact	R: Pin –	rhodium plating
J: Socket –	1,500-cycle contact	M: Socket –	rhodium plating
X: Pin –	with eyelet (hermetic)	G: Pin –	heavy gold plating
Z: Socket –	with eyelet (hermetic)	U: Socket –	heavy gold plating

The P, S, H, J, X, Z, C, D, R, M, G, and U designators are used to indicate that connectors will be supplied with a full complement of the applicable standard contacts as specified in MIL-STD-1560. These designators are part of the connector PIN and should be marked on the connectors. Contacts shall be obtained from a qualified AS39029 supplier.

4.2.1.8.2 Connectors Supplied Without Contacts

Contact designators for connectors supplied without contacts that are for use with separately sourced military specification contacts or nonstandard contact complements as specified in MIL-STD-1560 are as follows:

A – Pin contact insert

B – Socket contact insert

The A and B designators are used to indicate that the connectors will be used with other than standard contacts as specified in MIL-STD-1560 (example: shielded, coaxial thermocouple, fiber-optical contacts). The A and B designators are part of the connector PIN and should be marked on the connectors.

4.2.1.9 Polarization

A plug with a given rotation letter will mate with a receptacle with the same rotation letter. The angles for a given connector are the same whether it contains pins or sockets. Inserts are not rotated in conjunction with the master key/keyway. Figure 9 shows available keying angles, and Table 11 specifies the identification letter to use for PINs.

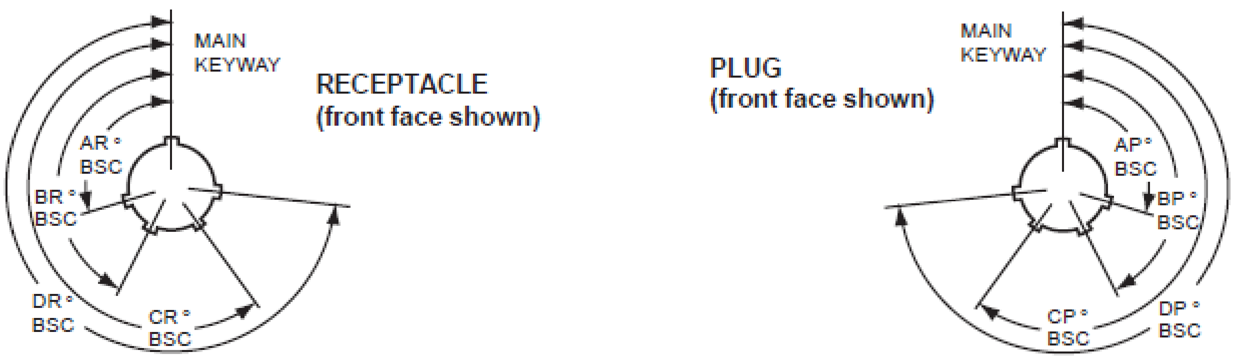


Figure 9. 38999 Polarization Angles

Table 11. Main Key and Keyway Polarization

Shell Size	Key & keyway arrangement identification letter	AR° or AP° BSC	BR° or BP° BSC	CR° or CP° BSC	DR° or DP° BSC
9	N	105	140	215	265
	A	102	132	248	320
	B	80	118	230	312
	C	35	140	205	275
	D	64	155	234	304
	E	91	131	197	240
11, 13, and 15	N	95	141	208	236
	A	113	156	182	292
	B	90	145	195	252
	C	53	156	220	255
	D	119	146	176	298
	E	51	141	184	242
17 and 19	N	80	142	196	293
	A	135	170	200	310
	B	49	169	200	244
	C	66	140	200	257
	D	62	145	180	280
	E	79	153	197	272
21, 23, and 25	N	80	142	196	293
	A	135	170	200	310
	B	49	169	200	244
	C	66	140	200	257
	D	62	145	180	280
	E	79	153	197	272
25L, 33, and 37	N	80	142	188	293
	A	135	170	188	310
	B	49	169	188	244
	C	66	140	188	257
	D	62	145	188	280
	E	79	153	188	272

4.2.1.10 Intended Use

Users of connectors, covered by this specification, in the designs of new systems and support equipment should carefully evaluate the relative merits of the long-shell Series I, III, and IV connectors, and the short-shell Series II connectors for each application. When short-shell Series II connectors are considered, the following areas must be evaluated:

a. Series II connectors are vulnerable to pin contact bending from scooping, with contact size 22 being the most vulnerable.

b. Use of Series II connectors must be avoided in areas of blind mating.

c. Receptacles must be located so as to minimize the amount of cable bending required. When using Series II connectors with large cables that must be bent at right angles, the cables must have the right-angle bend permanently established.

d. Series II connectors should not be used with heavy jacketed cable and excessive overhang moments, because of possible shell damage.

e. Series II connectors should not be used in areas where they will be subjected to rough handling, such as those areas near engine removal, generators, support equipment, or portable equipment.

f. When Series II connectors are mated in areas where visibility is difficult, care must be exercised to make sure that all bayonet pins are engaged by the coupling ring, since it is possible to engage only one bayonet pin, which means that the coupling is not complete.

g. When Series II connectors are mated in areas where visibility is difficult, care must be exercised to make sure that connector plugs with pins are not coupled to receptacles with pins. This situation will result in the contacts touching.

When the use of Series IV connectors is considered, the design of the coupling system should be evaluated. If the coupling mechanism between the coupling ring and the shell is not properly positioned prior to the mating operation, the coupling ring must be repositioned prior to mating.

Series I and II, Class P, connectors should not be used in new designs for the Air Force, except when specifically approved by the procuring activity.

When different classes and finishes are intermated, compatibility of connectors should be addressed. Galvanically incompatible classes and finishes should not be intermated. When classes with different performance requirements are intermated, the lower performance requirements of the two classes apply.

Composite-class connectors should be considered for applications requiring increased corrosion resistance, increased durability, or decreased weight.

Box-mount connectors are intended to be used on environmentally sealed boxes. If full wire-sealing capability is needed, a wall-mount or jam-nut-mount connector should be used.

4.2.2 MIL-DTL-5015 Connectors

MIL-DTL-5015 covers circular, threaded, electrical connectors with solder or removable crimp contacts (both front and rear release). These connectors are for use in electronic, electrical power, and control circuits.

4.2.2.1 PIN Construction

The following is an example of PIN construction for a MIL-DTL-5015 connector.

MS3452	W	-	18	-	10	P	W
Basic Part No.	Class	Material Designator	Shell Size		Insert Arrangement	Contact Designator	Insert Position

4.2.2.2 Basic Part Number

Electrical connectors covered by MIL-DTL-5015 are divided into classes, series, and receptacle styles. The basic part number specifies the series and receptacle and is shown on the applicable MS sheet. For a complete list of available receptacles, refer to QPL-5015-43. Table 12 lists commonly used receptacles by their respective basic part numbers. Available receptacle types not shown are cable connecting and solder mounting.

Table 12. MIL-DTL-5015 Connectors Commonly Used at KSC

MS3452	MS3454	MS3456
 Box-Mounting Receptacle	 Jam-Nut Receptacle	 Straight Plug

4.2.2.3 Classes

All classes listed in Table 13 are environment-resistant and fluid-resistant.

Table 13. Physical Characteristics of MIL-DTL-5015 Connector Classes

Class	Feature	Front-Release Crimp Contacts Series II	Rear-Release Crimp Contacts Series III	Hot Spot Temp (°C)	Service Life	Insert Material	Shells and Coupling Rings	
							Material	Finish
D	High-impact shock	X		125 175	20 yr 1,000 hr	Silicone	Wrought aluminum, stainless steel	Cadmium olive drab
K	Firewall	X	X	175	1,000 hr	Silicone	Ferrous alloy, stainless steel	Cadmium olive drab, stainless steel
L	Fluid-resistant	X	X	200	1,000 hr	Silicone	Aluminum, stainless steel	Electroless nickel, stainless steel
W	General-purpose	X	X	125 175	20 yr 1,000 hr	Silicone	Aluminum, stainless steel	Cadmium olive drab over nickel, stainless steel
DJ	High-impact shock with backshell connector assembly	X		125 175	20 yr 1,000 hr	Silicone	Wrought aluminum	Cadmium olive drab over nickel, stainless steel

4.2.2.4 Wire Range Accommodations

Table 14. Wire Range Accommodations

		Outside Diameter (OD) of Finished Wire (Inch) 1/					
Contact Size	Wire Size	Solder Contact Connectors		Crimp Contact Connectors			
				Front-Release		Rear-Release	
		Min 2/	Max	Min 2/	Max	Min 2/	Max
16-22 3/	26 24 22	N/A	N/A	0.066	0.130	N/A	N/A
16-16, 12-16 4/	20 18 16	0.064	0.130	0.066	0.130	0.053	0.103
12-12	14 12	0.114	0.170	0.097	0.170	0.085	0.158
8-8	10 8	0.164	0.255	0.132	0.255	0.132	0.255
4-4	6 4	0.272	0.370	0.237	0.370	0.237	0.370
0-0	2 0	0.415	0.550	0.360	0.550	0.360	0.550

1/ Wire reference MIL-W-16878, SAE-AS22759, MIL-DTL-81381, and MIL-DTL-915.
2/ For OD smaller than that specified, see 6.1.1.
3/ For Series II only.
4/ Only crimp contact connector data applies to size 12-16 contacts.

4.2.2.5 Material Designator

Material Designator	Shell and Coupling Ring Material	Finish	Classes
S	Stainless steel	Passivated stainless steel	D, K, L, DJ
T	Ferrous alloy	Cadmium olive drab	K
Leave Blank	Aluminum alloy	Electroless nickel	L
		Cadmium olive drab over nickel	W, DJ
	Wrought aluminum	Cadmium olive drab over nickel	D
	Ferrous alloy	Electroless nickel	K

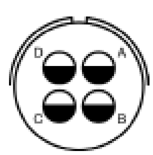
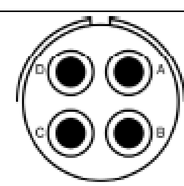
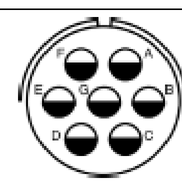
4.2.2.6 Shell Sizes

Shell sizes are designated as follows, except for Class DJ only where 10S, 12S, 14S, and 16S become 10, 13, 15, and 17, respectively, and 10SL becomes 11:

8S	16	32
10S	16S	36
10SL	18	40
12	20	44
12S	22	48
14	24	
14S	28	

4.2.2.7 Insert Arrangement

The service rating, quantity, size, and position of contacts shown on the insert arrangement should be as indicated in MIL-STD-1651.

Layout			
# of Contacts	18-10 4-#12	22-22 4-#8	20-15 7-#12

4.2.2.8 Contact Designator

4.2.2.8.1 Connectors With Contacts

The following designators are used to indicate a full complement of power contacts:

P: pin contacts

S: socket contacts

C: feedthrough

D: 16-22 pin contacts in lieu of 16-16 or where applicable, this designator indicates a full complement of 12-16 pin contacts in lieu of 12-12 (for Series II only)

E: 16-22 socket contacts in lieu of 16-16 or where applicable, the designator indicates a full complement of 12-16 socket contacts in lieu of 12-12 (for Series II only)

Connectors that accommodate crimp-removable contacts P, S, D, and E are permitted to be ordered without contacts by adding a note on the purchase order; however, the connector part numbers and marking requirements remain unchanged.

4.2.2.8.2 Connectors Without Contacts

The following designators are used to indicate connectors that do not have contacts. They are used only when power contacts are not being installed in the connector. Examples of this are shielded, thermocouple, and coaxial contacts.

A: without pin contacts

B: without socket contacts

4.2.2.8.3 Insert Position

The insert position is the angular position of the insert relative to the shell key or keyway. Insert positions other than normal are indicated by the letter shown in MIL-STD-1651.To avoid cross-plugging problems in application requiring the use of more than on connector of the same size and arrangement, alternate rotations are available as shown in Figure 10.

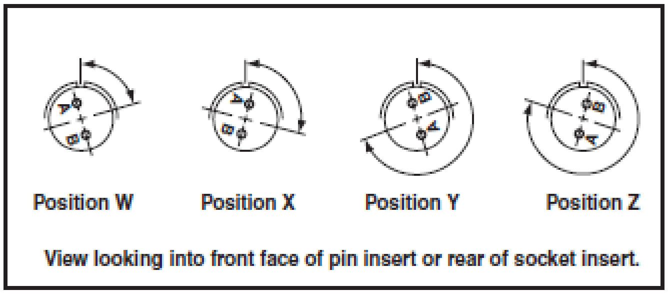


Figure 10. MIL-DTL-5015 Alternate Insert Positions

4.2.2.9 Intended Use

a. MS3100, MS3400, MS3450, and SAE-AS34001 are receptacles intended for wall- or bulkhead-mounting and for use with conduit or cable clamp.

b. MS3101, MS3401, MS3451, and SAE-AS34011 are receptacles intended for use at the end of a cable where mounting provisions are not required.

c. MS3102, MS3402, MS3452, and SAE-AS34021 are receptacles intended for mounting on shielding boxes and equipment cases. They have no fittings and are for use with open wiring. They are nonenvironmental and are intended for use on boxes where an environmental seal is achieved by some other means.

d. MS3404, MS3412, MS3454, SAE-AS34041, SAE-AS34121, and SAE-AS34541 are receptacles intended for wall- or bulkhead-mounting and for use with conduit or a cable clamp.

e. MS3106, MS3406, MS3409, MS3456, and SAE-AS34061 are plugs intended for use at the end of a cable to be mated with a receptacle. MS3409 is a 45° plug intended for use at the end of a cable where space does not permit the use of a straight plug.

f. MS3107 and MS3507 are plugs intended for use at the end of a cable that may require rapid disconnection from a receptacle.

g. MS3108 and MS3408 are 90° plugs intended for use at the end of a cable where space does not permit the use of a straight plug.

h. MS3103 is a receptacle intended for use in applications where a potted seal is required around wires.

i. MS25183 is a plug intended for use in applications where a potted seal is required around wires.

j. SAE-AS34591 is a plug with a self-locking coupling nut designed for firewall applications.

k. All classes of Series I are either canceled or inactive for new design. For the status of specific classes, see applicable MS sheets.

l. Class D connectors are intended for use where the connectors will be subjected to high-impact shock conditions beyond the capabilities of the other class connectors. These connectors have crimp contacts that are released from the front of the connector and a wire sealing range capable of sealing on naval shipboard cable. These connectors also have specified shell conductivity.

m. Class D, F, L, P, R, U, and W connectors are intended for use where the connector will be subjected to heavy condensation and rapid changes in temperature or pressure, and where the connector is subject to significant vibration. To ensure proper performance, a Class D, F, L, P, R, U, or W connector plug must always be mated to a Class D, F, L, P, R, U, or W receptacle. A Type MS3102 (F and R), MS3402 (D, L, U, and W), MS3412 (D, L, U, and W), SAE-AS34021 (D, L, U, and W), or SAE-AS34121 (D, L, U, and W) receptacle does not provide moisture or vibration protection at its back end; a Type MS3100 (F and R), MS3400 (D, L, U, and W), or SAE-AS34001 (D, L, U, and W) receptacle should be used if such protection is desired. Class F and R receptacles are intended for use on the walls and bulkheads of pressurized compartments and on the cases of pressurized equipment. They limit air leakage to the amount specified in 3.9.1, regardless of the type and class of plug mated to them. Potting form for Class P connectors should remain with the connector after potting.

n. Class K connectors are intended for use where it is necessary to maintain electrical continuity for a limited time, even though the connector is subjected to continuous flame. To ensure such continuity, both the receptacle and the mated plug must be Class K, and high-temperature wires must be used. If flame integrity only is desired, without the need for electrical continuity, a Class K receptacle must be used, but the mated plug may be of any type and class.

o. Class L connectors are intended for use where the connector will be subjected to elevated temperature 175 °C (347 °F) and where complete fluid resistance is required. These connectors have crimp contacts and are available in both front-release (MS34XX) and rear-release (MS345X) retention systems. These connectors have specified shell conductivity.

p. Class W connectors are intended for general use where complete fluid resistance is required. These connectors have crimp contacts and are available in both front-release (MS34XX) and rear-release (MS345X) retention systems.

q. Crimp contact connectors should have contacts installed in all positions when the connector is wired. Sealing plugs should be installed in the grommet holes when no wire is attached to the contact in grommet-sealed connectors.

r. Counterpart solder and crimp contact connectors are intended to be intermateable. Moisture resistance capability is then reduced to that of the solder contact connectors.

s. If air leakage requirements are critical, a resilient insert receptacle or Class H receptacle should be used, or the connector should be potted.

4.2.3 MIL-DTL-22992 Connectors

4.2.3.1 Characteristics

This specification covers multicontact, heavy-duty, quick-disconnect, waterproof, electrical plug and receptacle connectors and associated accessories for electronic and electrical power and control circuits. Connectors are rated for –55 °C to +125 °C (–67 °F to +257 °F).

4.2.3.2 PIN Construction

The following is an example of the PIN construction for MIL-DTL-22992 connectors.

MS17343	R	20	C	27	P	W
MS Number	Class	Shell Size	Finish	Insert Arrangement	Contact Style	Alternate Position

4.2.3.3 Classification

Electrical connectors and accessories are of the following types, classes, sizes, styles and arrangements, as specified.

4.2.3.3.1.1 Classes

Class C: pressurized

Class J: pressurized with grommet

Class L: arc-quenching

Class R: environment-resisting

4.2.3.3.1.2 Types

4.2.3.3.1.2.1 Plugs

a. Cable connecting plug (without coupling ring)

b. Straight plug

4.2.3.3.1.2.2 Receptacles

a. Wall-mounting receptacle

b. Box-mounting receptacle

c. Jam nut receptacle

d. Jam nut receptacle (box)

e. Wall-mounting receptacle (with coupling ring—Class L only)

4.2.3.3.1.2.3 Accessories

a. Cover, protective, receptacle (Types A and B)

b. Cover, protective, plug

c. Receptacle, dummy stowage

d. Adapter, straight through, cable sealing

    (1) Style 1 (Types A and B)

    (2) Style 2 (Types A and B)

e. Adapter, step-down, cable sealing

    (1) Style 1 (Types A and B)

    (2) Style 2 (Types A and B)

f. Adapter, step-up, cable sealing

(1) Style 1 (Types A and B)

(2) Style 2 (Types A and B)

4.2.3.3.1.3 Sizes

Connector and accessory sizes are as specified.

4.2.3.3.1.4 Connector Arrangements

Arrangements are as specified.

4.2.3.3.1.5 Styles

Style P: Inserts containing pin contacts

Style S: Inserts containing socket contacts

4.2.3.4 Intended Use

This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.

The various types and classes of connectors are intended for use as follows:

a. Class C connectors are intended for external interconnection use on vans, shelters, trailers, buildings, and heavy-duty (rough-service) applications. They are not for primary power distribution.

b. Class J connectors are intended for use only where Class C connectors can be used but where a wire support grommet is necessary.

c. Class L connectors are intended for power connections in the current range from 40 to 200 amperes (A), where heavy-duty, waterproof, and arc-quenching abilities are required and are to be used only with heavy-duty, jacketed cables specified on the applicable insert standard.

d. Class R connectors are intended for use as general-purpose, heavy-duty connectors, where pressurization and arc-quenching are not required. The connectors can be made weatherproof when the accessory sealing adapter is attached. They are not for primary power distribution.

4.2.4 MIL-DTL-26482 Connectors

MIL-DTL-26482 covers the general requirements for two series of environment-resisting, quick-disconnect, miniature, circular, electrical connectors (and accessories).

4.2.4.1 Characteristics

Each series contains hermetic receptacles. The two series of connectors are intermateable when using power contacts and are not intermateable when using shielded contacts. When intermated, the minimum performance requirement for Series I connectors shall be met.

4.2.4.1.1 Class

The class and series of connectors are identified as shown in Table 15.

Table 15. MIL-DTL-26482 Connector Class and Series

Class	Series I 125 °C (257 °F)		Series II 200 °C (392 °F)		Series II 175 °C (347 °F)
	Solder	Front-Release, Crimp-Removable Contacts	Rear-Release, Crimp-Removable Contacts	Solder	Rear-Release, Crimp-Removable Contacts
A: Grommet seal, nonconductive			X		
E: Grommet seal, conductive	X	X	1/		
P: Potted seal, conductive	X	X			
H: Hermetic seal, conductive	X			X	
J: insert seal with gland seal for jacketed cable, conductive	X				
L: Fluid resistant, conductive electroless nickel 1/ 2/			X		
N: Hermetic seal, crimp termination conductive					X
F: Grommet seal with strain relief clamp conductive	X	X			
W: Cadmium plate, corrosive and fluid resistant, conductive					X

1/ Class L is upgraded to 200 °C and replaces Class E, Series 2, rear releases, crimp removable contacts.
2/ Class L is for space applications only.

4.2.4.1.2 Shell Size

Shell sizes are as specified on the applicable MS standard.

4.2.4.1.3 Termination Type and Shell Material (Hermetic Receptacles Only)

The type of termination and shell material are designated as follows:

Type A: solder cup termination (may be hermetic) – stainless-steel shell (Series I and II)

Type B: eyelet termination – stainless-steel shell (Series I and II)

Type C: solder cup termination (may be hermetic) – ferrous-alloy shell (Series I and II)

Type D: crimp termination (may be hermetic) – ferrous-alloy shell (Series II)

Type Y: eyelet termination – ferrous-alloy shell (Series I)

4.2.4.1.4 Insert Arrangement

The insert arrangement, showing quantity, size, service rating, and positional location of contacts, is as specified in MIL-STD-1669.

4.2.4.1.5 Contact Style

a. Connectors ordered with standard contact arrangement in accordance with MIL-STD-1669 are as follows:

   C: feedthrough contact

   P: pin contacts

   S: socket contacts

   The C, P, and S designators are used to indicate that connectors will be used with full compliments of the applicable standard contacts in accordance with MIL-STD-1669.

   The connectors that accommodate crimp removable contacts (P and S) may be ordered without standard contacts by adding an appropriate note on the purchase order; however, the connector PIN and the marking requirements remain unchanged.

b. Connectors used with other than standard contact arrangements in accordance with MIL-STD-1669 are as follows:

   A: without pin contacts

   B: without socket contacts

   The A or B designators are used to indicate that the connectors will not be used with standard contacts, in accordance with MIL-STD-1669 (example: shielded, coaxial thermocouple, fiber-optical contacts). The A and B designators are part of the connector PIN and should be marked on the connectors.

The standard contacts should not be supplied with the connectors. The contacts that will be used with the connectors should be ordered separately.

NOTE

When standard power contacts are not used, the requirements stated herein need not be met.

4.2.4.1.6 Insert Position

The insert position is the angular position of the insert relative to the master key or keyway of the shell. Insert positions that are not normal are indicated by the letter shown on the insert arrangements specified in MIL-STD-1669.

4.2.4.2 Notes

This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.

4.2.4.2.1 Intended Use (Series I)

The various classes and types of connectors are intended for application as follows:

a. Class E, F, J, and P connectors are intended for use in environment-resisting applications where the operating temperature ranges from –55 ºC to +125 ºC (–67 ºF to +257 ºF). Crimp-contact connectors have the additional advantage of possessing removable crimp-type contacts. Class J connectors are intended for use with lightweight, single-jacketed cable.

b. Class H receptacles are intended for use in applications wherein pressures must be contained by the connectors across the walls or panels on which they are mounted.

c. Crimp-contact connectors should have contacts installed in all positions when the connector is wired. Sealing plugs should be installed in the grommet holes when no wire is attached to the contact in grommet-sealed connectors.

d. The potting form should remain with the connector after potting.

e. Counterpart solder and crimp contact connectors are intended to be intermateable. The ability to resist moisture is then reduced to that of the solder contact connector.

f. If air leakage requirements are critical, a resilient insert, a solder contact receptacle, a through-bulkhead receptacle, or a Class H receptacle should be used, or the connector should be potted.

g. Where two or more wires are used in a solder cup or wire barrel, grommet sealing is not obtainable. Wires should be potted if sealing is required.

4.2.4.2.2 Intended Use (Series II)

a. Connector backshells must be installed to meet the specified moisture-sealing requirements.

b. Class A connectors are intended for use in application where the temperature will reach 200 ºC (392 °F) or where grommet seals or nonconductive finishes are required.

c. Class L connectors are intended for use in environment-resisting applications where the temperature will reach 200 ºC (392 °F) or where fluid resistance will be required. These connectors have wire-sealing grommets.

d. Class H and N receptacles are intended for use in applications wherein pressure must be contained by the connectors across walls or panels on which they are mounted. They have fluid-resistant insert face seals. In addition, Class N receptacles have crimp-type terminations.

e. Mechanical strain reliefs are intended for use where a saddle-type clamp is desired.

f. Shielded contacts are intended for use with shielded and jacketed single-conductor cables, and may be used with certain coaxial cables when impedance matching is not required. Shielded contacts are not furnished with connectors and must be ordered separately when required. Shielded contacts will not intermate with standard size 12 contacts or with Series I shielded contacts. It is the user's responsibility to ensure mating contact compatibility at the time of contact installation.

g. RFI backshell and grounding fingers on plugs are available in Class L and provide RFI shielding.

h. Class W connectors are intended for use in salt spray environments. They provide a corrosion-resistant shell, a conductive finish, and fluid resistance at a service temperature of 175 °C (347 ºF).

4.3 Fiber-Optical Connectors Commonly Used at KSC

Fiber-optical connectors are typically determined by the end items or equipment to which they are connected. KSC uses a variety of fiber-optical connectors. Fiber-optical connectors are also available for harsh environments and circular connections.

Table 16 shows the connectors used most commonly at KSC. The descriptions are of typical applications and do not limit the use of the connectors.

Table 16. Fiber Connectors Commonly Used at KSC

<table>
<tr><th>Connector Type</th><th>Coupling Type</th><th>Fiber Type</th><th>Polish</th><th># of Fibers</th><th>Typical Application</th><th>Comment</th></tr>
<tr><td rowspan="2">
ST</td><td>Twist-On</td><td>Single-mode/ Multimode</td><td>PC, UPC</td><td>1</td><td>Local Area Networks</td><td>Keyed</td></tr>
<tr><td colspan="6">ST (an AT&T trademark) is the most commonly used connector for multimode networks, such as most buildings and campuses. It has a bayonet mount and a long cylindrical ferrule to hold the fiber. Most ferrules are ceramic, but some are metal or plastic.</td></tr>
<tr><td rowspan="2">
FC</td><td>Screw-On</td><td>Single-mode/ Multimode</td><td>PC, UPC, APC</td><td>1</td><td>Datacom, Telecommunications, Test Equipment</td><td>Keyed</td></tr>
<tr><td colspan="6">FC/PC has been one of the most commonly used single-mode connectors for many years. It screws on firmly, but care must be taken to make sure that the key is aligned in the slot properly before it is tightened. It is being replaced by SCs and LCs.</td></tr>
<tr><td rowspan="2">
SC</td><td>Snap-On</td><td>Single-mode/ Multimode</td><td>PC, UPC, APC</td><td>1</td><td>Community Antenna TV, Test Equipment, Telecommunications</td><td>Keyed</td></tr>
<tr><td colspan="6">SC is a snap-on connector that is widely used in single-mode systems for its excellent performance. It latches with a simple push-pull motion. It is also available in a duplex configuration.</td></tr>
<tr><td rowspan="2">
LC</td><td>Snap-On RJ45-Style</td><td>Single-mode/ Multimode</td><td>PC, UPC, APC</td><td>1</td><td>Gigabit Ethernet, Video Multimedia, Telecommunications</td><td>Small Form Factor (SFF)</td></tr>
<tr><td colspan="6">LC is a new connector that uses a 1.25 mm ferrule, half the size of the ST. Otherwise, it is a standard ceramic ferrule connector, easily terminated with any adhesive. It performs well and is highly favored for high-port-density applications. It is also available in a duplex configuration.</td></tr>
</table>

ST, SC, and LC connectors are spring-loaded and must be seated properly. High-loss problems may be solved by reestablishing the connection.

Connectors with an angled physical contact (APC) are not intermateable with physical-contact (PC) or ultra-physical-contact (UPC) connectors.

5. HEAT-SHRINKABLE TUBING

Heat-shrinkable tubing provides a method for applying a tight, protective covering to items that will subjected to extremes of heat, corrosion, shock, moisture, and other critical environmental conditions.

Heat-shrinkable tubing as specified by SAE AMS-DTL-23053 or MIL-PRF-46846C should have a recovered diameter slightly smaller than that of the calculated overall diameter of the conductor bundle with overall shield. The length specified should be 10 percent greater than the area to be covered to allow for length shrinkage as a result of heating.

6. PREPARATION FOR DELIVERY

6.1 Preservation and Packaging

Packaging shall be in accordance with the Level A requirements of MIL-DTL-12000 and as follows.

6.1.1 Reels and Spools

Cable shall be delivered on reels or spools. The cable shall be wound on the reel or spool so that both ends are accessible for testing.

6.1.2 Cable Lengths

Cable cutting lengths shall be as specified in the contract. Each individual continuous length of cable shall be packaged on a separate reel or spool.

6.2 Packing

Unless otherwise specified in the contract, packing shall be in accordance with the level temperature requirements specified in MIL-DTL-12000.

6.3 Marking for Shipment

Cable reels or spools and exterior shipping containers shall be marked in accordance with MIL-DTL-12000 and MIL-STD-129. The identification shall include the following information:

a. Cable part number

b. Specification 120E3100001, 120E3100002, or KSC-SPEC-E-0031 (not recommended for new design)

c. Length (   ) meters (or [   ] feet)

d. Date of manufacture

e. Name of manufacturer

f. Results of manufacturer's testing

Custodian:

NASA – John F. Kennedy Space Center
Kennedy Space Center, Florida 32899

Preparing Activity:

John F. Kennedy Space Center
Engineering Directorate
Electrical Division

APPENDIX A. OHM'S LAW AND CONVERSION TABLE

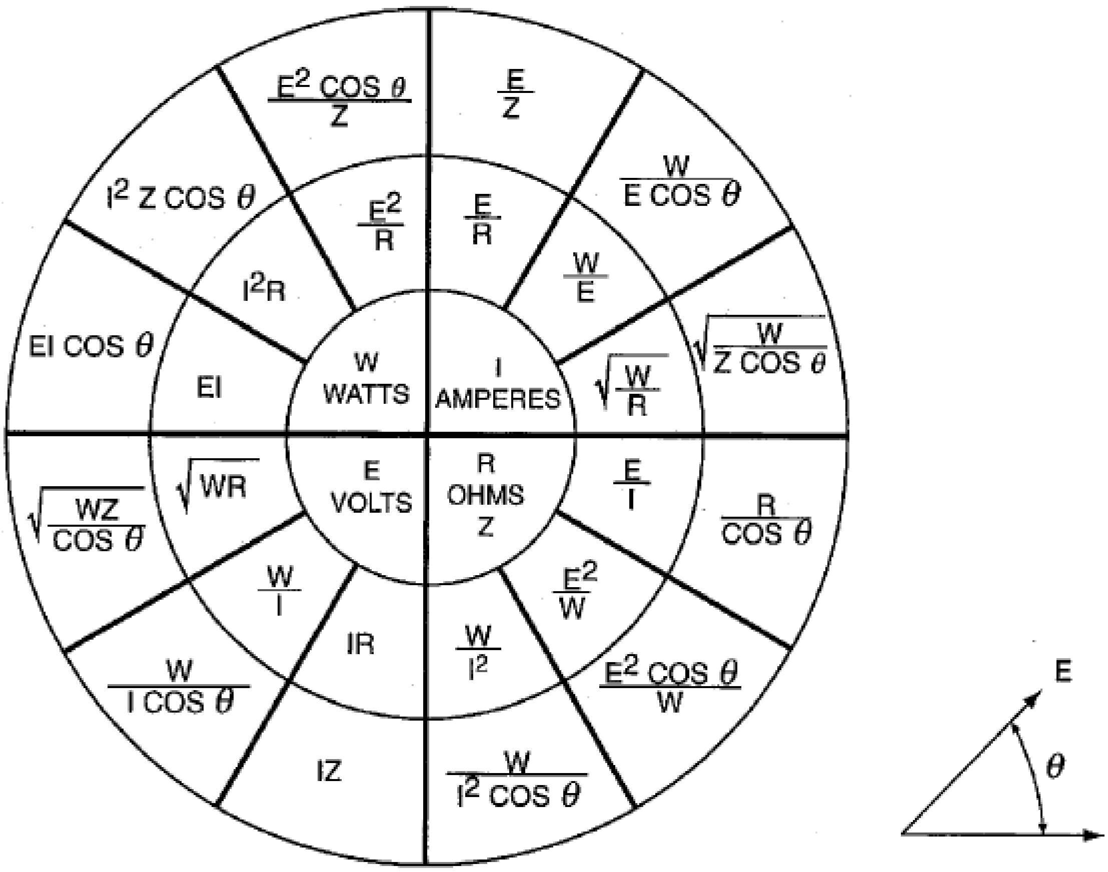


Figure 11. Ohm's Law

Table 17. Conversion Table

in × 2.54 = cm	in^3 × 16.387 = cm^3
ft × 30.4 = cm	ft^3 × 0.028 = m^3
mi × 1.6093 = km	ft^3 × 7.481 = gal
in^2 × 6.452 = cm^2	ft^3 × 28.316 = L
ft^2 × 0.0929 = m^2	gal × 231 = in^3
gal × 3,785 = cm^3	fl oz × 0.029 = L
gal × 3.78 = L	lb × 453.6 = g
Avoir oz × 28.35 = g	

cm = centimeter	ft^2 = square foot	in^2 = square inch	m - meter
cm^2 = square centimeter	ft^3 = cubic foot	in^3 = cubic inch	m^2 = square meter
cm^3 = cubic centimeter	g = gram	km = kilometer	m^3 = cubic meter
fl oz = fluid ounce	gal = gallon	L = liter	mi = mile
ft = foot	in = inch	lb = pound	oz = ounce

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APPENDIX B. ENVIRONMENTAL CONDITIONS

B.1 Natural-Environment Conditions at Kennedy Space Center

B.1.1 Thermal Radiation

Exterior GSE cables and connectors will be exposed to both direct solar radiation and diffuse (sky) radiation. Materials used for the cables, particularly the jacketing, should retain their properties through years of exposure. The information shown in Table 18 and Table 19 is taken from NASA-HDBK-1001, Section 4.

Table 18. Maximum and Minimum Design Surface Air Temperatures

Local Standard Time	Annual Maximum Temperature		Annual Minimum Temperature	
	°C	°F	°C	°F
1 a.m.	28.9	84	–3.3	26
2 a.m.	28.9	84	–3.9	25
3 a.m.	29.4	85	–4.4	24
4 a.m.	28.3	83	–4.4	24
5 a.m.	28.9	84	–5.0	23
6 a.m.	29.4	85	–5.6	22
7 a.m.	30.6	87	–6.1	21
8 a.m.	31.1	88	–5.6	22
9 a.m.	33.3	92	–3.9	25
10 a.m.	34.4	94	–2.2	28
11 a.m.	35.0	95	–1.7	29
12 noon	36.1	97	–0.6	31
1 p.m.	37.2	99	0.0	32
2 p.m.	36.1	97	+2.8	37
3 p.m.	36.7	98	+2.8	37
4 p.m.	36.1	97	+2.2	36
5 p.m.	36.1	97	+1.1	34
6 p.m.	35.0	95	0.0	32
7 p.m.	33.3	92	–0.6	31
8 p.m.	31.7	89	–1.1	30
9 p.m.	31.1	88	–1.7	29
10 p.m.	30.0	86	–2.2	28
11 p.m.	30.0	86	–2.2	28
12 midnight	30.0	86	–2.2	28

Table 19. Surface Thermal Radiation

Surface Air Temperature Extremes					Sky Radiation	
	Maximum Extreme	95%	Minimum Extreme	95%	Extreme Minimum Equivalent Temperature	Equivalent Radiation (g-cal $cm^{-2}min^{-1}$)
°C	37.2	35.0	–7.2	0.6	–15.0	0.36
°F	99	95	19	33	5	

B.1.2 Humidity

Cables and connectors used in GSE should withstand physical and chemical deterioration caused by humidity. The information shown in Table 20 is taken from NASA-HDBK-1001, Section 6.

Table 20. Vapor Concentration

Minimum Vapor Concentration		Temperature Associated With Minimum Vapor Concentration		Maximum Vapor Concentration		Temperature Associated With Maximum Vapor Concentration	
(g/m^{-3})	(g/ft^{-3})	(°C)	(°F)	(g/m^{-3})	(g/ft^{-3})	(°C)	(°F)
1.5	0.7	7.0	45	27.0	11.8	30.5	87

B.1.3 Atmospheric Constituents

Gases and particles in the atmosphere should be considered in GSE design. Cable and connector materials should resist corrosion and abrasion caused by aerosols. The information shown in Table 21 and Table 22 is taken from NASA-HDBK-1001, Section 10.

Table 21. Relative Corrosivity of Atmosphere

Location	Type of Atmosphere	Average Weight Loss of Iron Specimens in 1 Year (mg/cm^2)	Relative Corrosivity
Daytona Beach, Florida	Marine	35.68	475

Table 22. Mean Sea Salt Particle Concentrations in Maritime Air Masses

Altitude	Concentration (cm^{-3})
Sea Level	200 to 300

B.1.4 Combustion and Other Man-Induced Aerosol

The firing of solid rocket motors (SRMs) during a rocket launch or static test is an example of an emission source that is of particular importance for aerospace activities. The by-products of the SRMs include a significant amount of gaseous hydrogen chloride (HCl) and particulate aluminum oxide (Al_2O_3). The mass fractions of HCl and Al_2O_3 in SRM exhaust are 0.21 and 0.30, respectively. In test and launch configurations that use substantial amounts of water for cooling or sound suppression, or when rain, fog, or other natural sources of water are present, the HCl gas and Al_2O_3 particulates will combine with the water, yielding an acidic deposition that will be dispersed by the exhaust plume over the facility and may be carried downwind as well. GSE cables and connectors should withstand these conditions. See NASA-HDBK-1001 Section 10.

B.1.5 Water

Exterior cables and connectors will be exposed to precipitation and, in some areas, water from the sound suppression system. Materials used should be operational during wet conditions.

B.2 Environment Induced by the Crew Launch Vehicle Mobile Launcher Solid Rocket Motor Exhaust Plume

B.2.1 Acoustic and Vibration

GSE located near the rocket will experience harsh acoustic and vibration effects. KSC-NE-8764, Volume I, describes the induced acoustic and vibration environment.

B.2.2 Heating Rate and Impact Pressure

The launch environment imposes high heating rates and impact pressures on surrounding cables and connectors. KSC-NE-8764, Volume II, describes the induced thermal environment.

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APPENDIX C. INSULATION AND JACKETING CHARACTERISTICS

C.1 Typical Characteristics of Popular Insulations

See Table 23 (at the end of C.1) for a comparison of the typical properties of insulation materials.

C.1.1 Polyvinyl Chloride (PVC)

The following types of PVC are in general use at KSC.

- **Standard PVC** is the most common jacket material used for applications of 1,000 V or less for hook-up, computer, and control wires. Different compounds are used for 60 °C, 80 °C, 90 °C, and 105 °C (140 °F, 176 °F, 194 °F, and 221 °F) service, and for commercial and military applications.

- **Semirigid PVC** is much tougher than standard PVC. It has greater resistance to abrasion and cut-through and more stable electrical properties.

- **Irradiated PVC** has improved resistance to abrasion, cut-through, soldering, and solvents. Irradiation changes the vinyl from a thermoplastic to a thermosetting material.

Depending upon the formulation, the rated temperature will vary from –55 °C to +105 °C (–67 °F to +221 °F). Typical dielectric constant values can vary from 2.7 to 6.5.

C.1.2 Polyethylene (Solid and Cellular)

Polyethylene (solid and cellular) has very good electrical-insulation properties: a low dielectric constant, a stable dielectric constant over all frequencies, and a very high insulation resistance. Polyethylene can be stiff to very hard, depending on the molecular weight and density. Low-density formulations are the most flexible, and high-density, high-molecular-weight formulations are very hard. Moisture resistance is excellent, but both types are flammable. Brown and black formulations have excellent weather resistance. The dielectric constant is 2.3 for solid insulation and 1.5 for cellular (foamed) designs.

C.1.3 Rulan

Rulan (a DuPont trade name) is a polyethylene with flame-retardant additives. The additives have only a slight effect on physical or electrical properties of the insulation.

C.1.4 CSPE (Hypalon)

Chlorosulfonated polyethylene (CSPE), better known as Hypalon (a DuPont trade name), is used as a 105 °C (221 °F)-rated motor lead wire insulation but is primarily a jacketing compound. It has excellent tear and impact strength; excellent resistance to abrasion, ozone, oil, and chemicals; and good weathering properties. The material also has low moisture absorption, excellent resistance to flame and heat, and good dielectric properties.

C.1.5 Polypropylene (Solid and Cellular)

The electrical properties of polypropylene (solid and cellular) are similar to those of polyethylene. Polypropylene is primarily used as insulation. Typically, it is harder than polyethylene. This makes it suitable for thin-wall insulations. The UL maximum temperature ratings may be 60 °C or 105 °C (140 °F or 221 °F). Most UL styles call for 60°C maximum. The dielectric constant is 2.59 for solid and 1.55 for cellular (foamed) designs.

C.1.6 Kynar

Kynar (an Arkema Inc. trade name) has great mechanical strength, superior resistance to abrasion and cut-through, and substantially reduced cold-flow, which make it an excellent backplane wire insulation. Kynar is self-extinguishing and radiation-resistant. It is a 135 °C (275 °F) material.

C.1.7 ETFE (Tefzel)

Ethylene tetrafluoroethylene (ETFE), better known as Tefzel (a DuPont trade name), is a 150 °C (302 °F) material and chemically inert. It has very good electrical properties, high flex life, and exceptional impact strength. It can withstand an unusual amount of physical abuse and is self-extinguishing.

C.1.8 ECTFE (Halar)

Ethylene chlorotrifluoroethlyene (ECTFE) better known as Halar (an Ausimont Corporation trade name) has a specific gravity of 1.68, the lowest of any fluorocarbon. Its dielectric constant and dissipation factor at 1 megahertz (MHz) are 2.6 and 0.013, respectively. Halar chars but does not melt or burn when exposed to direct flame, and immediately extinguishes on flame removal. Its other electrical, mechanical, thermal, and chemical properties are almost identical to those of Tefzel. The temperature rating is –70 °C to +150 °C (–94 °F to +302 °F).

C.1.9 FEP (Teflon)

Fluorinated ethylene-propylene (FEP), better known as Teflon (a DuPont trade name), is extrudable in a manner similar to PVC and polyethylene. This means that long wire and cable lengths are available. It has excellent electrical characteristics, is chemically inert, and has a service temperature of 200°C (392 °F).

C.1.10 TFE (Teflon)

Tetrafluoroethylene (TFE), better known as Teflon (a DuPont trade name), is extrudable in a hydraulic-ram-type process. Lengths are limited by the amount of material in the ram, the thickness of the insulation, and the preform size. TFE must be extruded over a silver- or nickel-coated wire. The silver- and nickel-coated designs are rated at 200 °C (392 °F) and 260 °C (500 °F), respectively.

C.1.11 PFA

Perfluoroalkoxy (PFA) is the latest addition to DuPont's Teflon resins. Like the other Teflon resins, it has outstanding electrical properties, high operating temperature (250 °C [482 °F]), resistance to virtually all chemicals, and flame resistance. The cost per pound of Teflon is approximately 8 to 10 times that of PVC compounds.

C.1.12 Thermoplastic Rubber (TPR)

The properties of TPR are similar to those of vulcanized (thermosetting) rubbers. The advantage is that it can be processed the same way as thermoplastics and extruded over the conductor. Like many conventional rubber materials, TPR is highly resistant to oils, chemicals, ozone, and other environmental factors. It has low water absorption and excellent electrical properties, and is very flexible, with good abrasion resistance.

C.1.13 Silicone

Silicone is a very soft insulation with a typical temperature range from –80°C to +250°C (–112 °F to +482 °F). It has excellent electrical properties, plus ozone resistance, low moisture absorption, weather resistance, and radiation resistance. It typically has low mechanical strength and poor scuff resistance. Though silicone rubber burns slowly, it forms a nonconductive ash, which, in some cases, can maintain the integrity of the electrical circuit.

C.1.14 Ethylene Propylene Rubber (EPR)

EPR is a chemically cross-linked, thermosetting, high-temperature rubber insulation. It has excellent electrical properties, combined with outstanding thermal stability and flexibility. Its resistance to compression, cutting, impact, tearing, and abrasion is good. EPR is not attacked by acids, alkalis, or many organic solvents. It is also highly moisture-resistant. It has temperature ratings up to 150 °C (302 °F).

C.1.15 Cross-Linked Polyethylene (XLP)

XLP is rated up to 150°C (302 °F). Cross-linking changes thermoplastic polyethylene to a thermosetting material, which has greater resistance to environmental stress cracking, cut-through, ozone, solvents, and soldering than either low- or high-density polyethylene. XLP is sometimes designated as XLPE. It can be cross-linked either chemically or by irradiation.

C.1.16 Styrene Butadiene Rubber (SBR)

SBR is flexible and offers good heat and moisture resistance at an economical cost. It must be jacketed for mechanical and chemical protection. It has a maximum temperature rating of 75°C (167 °F).

Table 23. Typical Properties of Insulation Materials

	PVC	PE	XLPE	FEP	TFE	SBR	Silicone Rubber
Specific Gravity	1.37	0.92	1.20-1.40	2.20	2.15	1.40	1.24
Tensile Strength (PSI × 1,000)	1.5 to 3.8	1.4 to 2.4	1.8 to 2.5	2.3 to 3.1	2.6 to 6.0	0.5 to 1.5	0.6 to 1.2
Elongation (%)	200 to 375	350 to 550	250 to 400	200 to 330	200 to 500	200 to 400	125 to 400
Service Temp Range	–55 to +105 °C	–20 to +75 °C	–65 to +150 °C	–70 to +200 °C	–70 to +260 °C	–40 to +75 °C	–70 to +200 °C
	–67 to +221 °F	–4 to +167 °F	–85 to 302 °F	–94 to +392 °F	–94 to 500 °F	–40 to +167 °F	–94 to +392 °F
Dielectric Strength: V/mil – 0.40" wall	800	1050	700	950	950	500	400
Dielectric Constant 60 Hz to 1 MHz)	5.0	2.26	3.0	2.15	2.1	4.0	3.1
Water Absorption (% in 24 hr)	<0.75	<0.02	<0.01	<0.01	<0.01	<1.0	<1.0
Flame Resistance	Self-Extinguishing	Supports Flame	Slow-Burning	Nonflammable	Nonflammable	Slow-Burning	Slow-Burning
Ozone Resistance	Excellent	Good	Good	Excellent	Excellent	Excellent	Excellent
Flexibility	Good	Good	Fair to Good	Good	Good	Excellent	Excellent
Abrasion Resistance	Good	Good	Excellent	Excellent	Excellent	Poor	Poor

C.2 Common Jacket Types

See Table 24 (at the end of C.2) for a comparison of the typical properties of jacket materials.

C.2.1 Polyvinyl Chloride (PVC)

PVC is an inherently flame- and abrasion-resistant thermoplastic material that is specially compounded for general-purpose applications at temperatures to 105°C (221 °F).

C.2.2 Chlorinated Polyethylene (CPE)

CPE is available in both thermoplastic and thermosetting versions. It has excellent flame resistance, chemical resistance, and cold-temperature properties. The temperature range is –40 °C to +105 °C (–40 °F to +221 °F).

C.2.3 Thermoplastic Elastomer (TPE) or Thermoplastic Rubber (TPR)

TPE (or TPR) has the mechanical characteristics of thermoset rubbers yet is a thermoplastic. It has excellent ozone and chemical resistance, excellent electrical properties, and low water absorption. The temperature range is –70 °C to +125°C (–94 °F to +257 °F).

C.2.4 Neoprene

Neoprene is a polychloroprene and a thermosetting compound. It is flexible; has good oil, ozone, heat; and weather resistance; and is specified for outdoor applications because of its weather, sunlight, and cold-temperature properties. It will not support combustion but resists abrasion and cutting.

C.2.5 CSPE (Hypalon)

Chlorosulfonated polyethylene (CSPE), better known as Hypalon (a DuPont trade name), is a thermosetting compound. It can be formulated for almost total resistance to ozone attack, which can destroy many kinds of nonmetallic materials. It also exhibits good resistance to oxidation by sunlight, weathering, chemicals, and high temperatures. Besides radiation resistance, it has fair cold-temperature properties compared to neoprene. The material has low moisture absorption and good dielectric properties.

C.2.6 Polyurethane

Polyurethane has exceptional resistance to oil, radiation, fungus, oxidation, and ozone. It is unusually tough, and has higher tensile strength and elongation, more abrasion resistance, and better low-temperature flexibility than neoprene. Its major disadvantage is poor resistance to steam, high temperatures, and acids. But it has outstanding "memory" properties, making it an ideal jacket material for retractile cords. Because it is expensive, it is only specified when other jacket materials will not satisfy the requirements of the application

Table 24. Typical Properties of Jacket Materials

	PVC	**PE**	**Nylon**	**FEP**	**TFE**	**Neoprene**
Specific Gravity	1.37	0.92	1.09	2.20	2.15	1.52
Tensile Strength (PSI × 1,000)	1.5 to 3.8	1.4 to 2.4	8.8 to 11.9	2.3 to 3.1	2.6 to 6.0	2.5-4.0
Elongation (%)	200 to 375	350 to 550	150 to 380	200 to 330	200 to 500	300-500
Service Temp Range	–55 to +105 °C	–20 to +75 °C	–55 to +105 °C	–70 to +200 °C	–70 to +260 °C	–30 to +90 °C
	–67 to +221 °F	–4 to +167 °F	–67 to +221 °F	–94 to +392 °F	–94 to 500 °F	–22 to +194 °F
Ozone Resistance	Excellent	Good	Good	Excellent	Excellent	Excellent
Weatherability	Fair to Good	Good to Excellent	Fair to Poor	Excellent	Excellent	Good
Flame Resistance	Self-Extinguishing	Supports Flame	Self-Extinguishing	Nonflammable	Nonflammable	Self-Extinguishing
Abrasion Resistance	Fair-Good	Good	Excellent	Excellent	Excellent	Excellent
Flexibility	Good	Poor-Good	Good	Fair to Good	Good	Excellent
Acid Resistance	Fair-Good	Excellent	Excellent	Poor	Excellent	Good
Hydraulic-Fluid Resistance	Fair	Fair to Good	Fair-Poor	Fair to Good	Excellent	Good
Organic-Solvent Resistance	Good	Fair to Poor	Poor	Fair to Good	Excellent	Good
Resistance to Tearing	Good	Good	Good	Excellent	Good	Good

APPENDIX D. CABLE SUBASSEMBLY DRAWINGS

A cable subassembly drawing provides information about the characteristics of a cable assembly or harness. The cable subassembly drawing specifies cables, connectors, accessories, wiring schematic, and fabrication instructions that are required in order to build a cable assembly or a harness assembly. Each subassembly is a standard item and may be used on the cable assembly drawings for many different subsystems. For this reason, when a new cable subassembly is needed, the subsystem designers should check to see if the subassembly already exists. If it does, the current drawing number can be added to that subsystem's cable assembly drawing, including its specified length.

When a new cable subassembly is needed, the subsystem designer should use the following steps to create a new drawing. A drawing number can be requested through the Engineering Documentation Center (EDC). All cable subassembly drawings will have a standard 120E34XXXXX number.

The cable subassembly drawing consists of a title/security page (KSC Form 21-617), a material list page (KSC Form 21-2F with a table added), and a continuation/last page (KSC Form 21-2F). Not all pages must be used. The title/security page and material list page will always be used. If more space is needed for the wiring schematic, either the continuation or last page may be used. See examples and detailed instructions for each page in the following pages. For more detailed information on this or any drawing, consult KSC-GP-435.

Once a drawing had been completed, it should be reviewed by a checker before being submitted to the EDC.

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APPLICATION		REVISION HISTORY					
NEXT ASSY	USED ON	PART NO.	ZONE	REV	DESCRIPTION	DATE	APPROVAL
(19)	(20)				(18)		

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REV (3) | SHEET 1 (2) | DWG NO (1)

CAD MAINTAINED. CHANGES SHALL BE INCORPORATED ONLY BY THE DESIGN ACTIVITY	ORIGINAL DATE OF DRAWING (8)		JOHN F. KENNEDY SPACE CENTER, NASA KENNEDY SPACE CENTER, FLORIDA
SOFTWARE AUTOCAD ELECTRICAL (25)	DRAFTSMAN (14)	CHECKER (17)	TITLE1 (7)a
FILENAME PAGE_TITLE (24)	ENGINEER (13)	CHECKER (16)	TITLE2 (7)b
MATERIAL (23)	ENGINEER (12)	STRESS (15)	TITLE3 (7)c
HEAT TREATMENT (22)	ENGINEER (11)		SIZE A / CAGE CODE 22264 (5) / DWG NO (1) / REV (3)
FINAL PROTECTIVE FINISH (21)	SUBMITTED (10)		SCALE NONE (6) / UNIT WEIGHT (4) / SHEET 1 OF (2)
	APPROVED (9)		

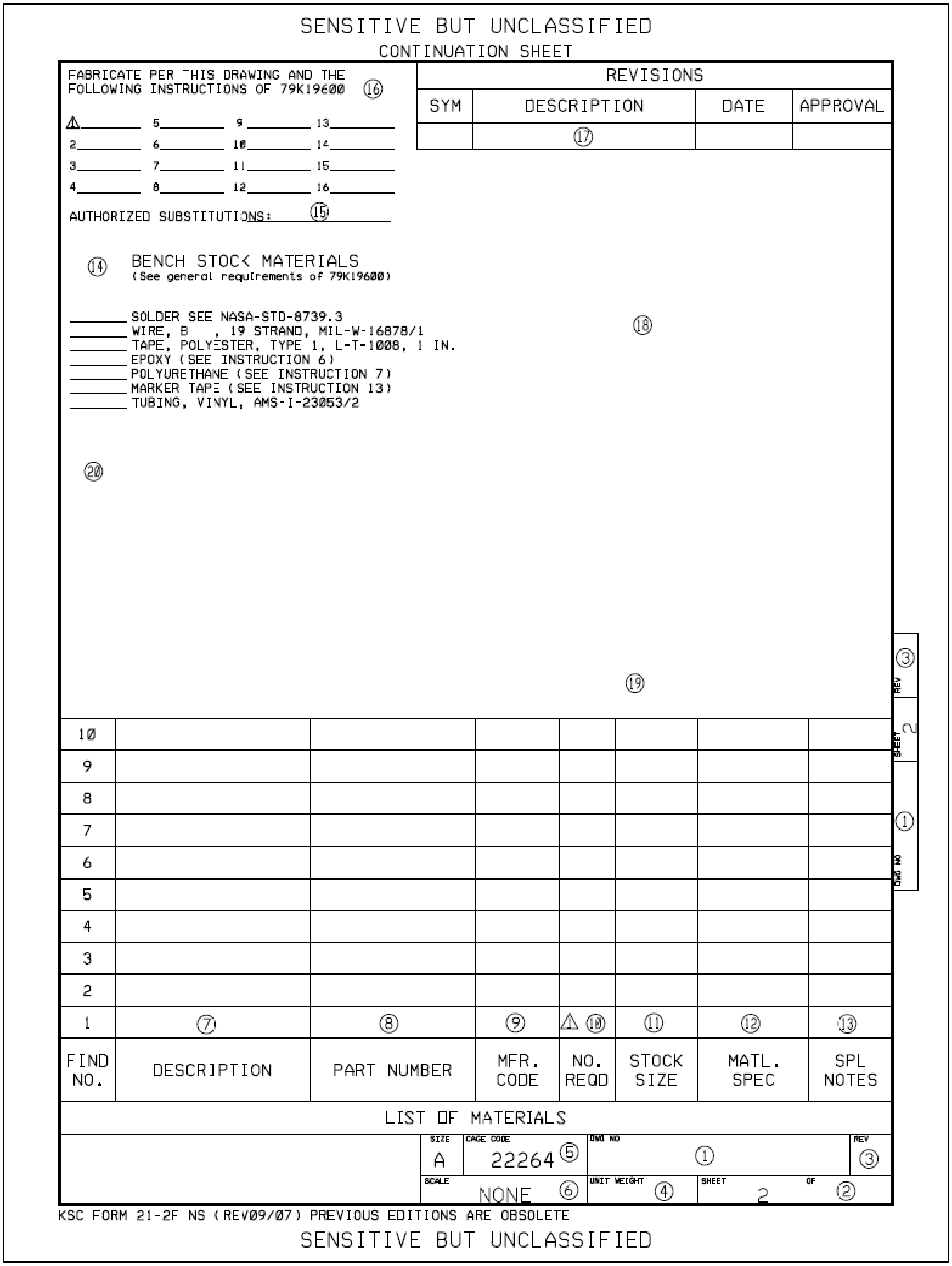
KSC FORM 21-617 NS (REV09/07) PREVIOUS EDITIONS ARE OBSOLETE

SENTITIVE BUT UNCLASSIFIED

Figure 12. Cable Subassembly Drawing – Title Page

D.1 Entry Descriptions For Cable Subassembly Drawing – Title Page

1. Drawing number.
2. Sheet number and total sheets in drawing (e.g., 1 of 3).
3. Revision letter, if not the original drawing (e.g., A or B).
4. Unit weight – not applicable – leave blank.
5. Type cage number for KSC – 22264 (if not prefilled).
6. Scale – not applicable – leave blank.
7. Title of drawing to include the following:
   a. Type words: "Cable Subassembly"
   b. Build-up of the cable, e.g., 8 (4PTSI#20) OSFBI
   c. Connector part numbers, e.g., D38999/ 26WD15PN / D38999/26WD15SN
8. Original date of drawing, using YY/MM/DD or YYYY/MM/DD (e.g., 08/09/27).
9. Signature, name, or approval indicator of the responsible NASA supervisor or manager authorized to approve the drawing.
10. Signature, name, or approval indicator of the engineer submitting the drawing for approval.
11. Name of the design engineer.
12. Name or initials of the materials and processes engineer authorized to approve the drawing.
13. Name or initials of any additional engineer.
14. Name or initials of the draftsman.
15. Name of the stress engineer – not applicable – leave blank.
16. Name or initials of the checker.
17. Name or initials of other checker.
18. Revision information:
    PART NO. – enter the part number to which the drawing applies, if applicable
    ZONE – leave blank
    REV – enter the revision letter of the drawing revision (e.g., A or B)
    DESCRIPTION – enter a brief description of the changes made by the revision, including the sheet numbers and the change action applicable to each sheet (e.g., Revision, Added, Deleted, or Redrawn)
    DATE – enter the date of the revision (e.g., YY/MM/DD or YYYY/MM/DD)
    APPROVAL – enter the signature, initials, name, or approval indicator of the responsible engineer or supervisor, and the materials and processes engineer authorized to approve the revision
19. Next higher assembly number – not applicable – leave blank.
20. Name of the program or hardware for which the drawing is used (e.g., KSC GSE, KSC, Orion, or Ares).
21. Applicable final protective finish and specification.
22. Applicable heat treatment and specification.
23. Applicable material specification.
24. CAD file name – type drawing number here (e.g., 120E3400001).
25. CAD software used – type "AUTOCAD ELECTRICAL" if not prefilled.



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CONTINUATION SHEET

FABRICATE PER THIS DRAWING AND THE FOLLOWING INSTRUCTIONS OF 79K19600 (16)

△____	5____	9____	13____
2____	6____	10____	14____
3____	7____	11____	15____
4____	8____	12____	16____

AUTHORIZED SUBSTITUTIONS: (15)

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL
	(17)		

(14) BENCH STOCK MATERIALS
(See general requirements of 79K19600)

____ SOLDER SEE NASA-STD-8739.3
____ WIRE, B , 19 STRAND, MIL-W-16878/1
____ TAPE, POLYESTER, TYPE 1, L-T-1008, 1 IN.
____ EPOXY (SEE INSTRUCTION 6)
____ POLYURETHANE (SEE INSTRUCTION 7)
____ MARKER TAPE (SEE INSTRUCTION 13)
____ TUBING, VINYL, AMS-I-23053/2

(18)

(20)

(19)

REV (3) SHEET 2 DWG NO (1)

FIND NO.	DESCRIPTION	PART NUMBER	MFR. CODE	NO. REQD	STOCK SIZE	MATL. SPEC	SPL NOTES
10							
9							
8							
7							
6							
5							
4							
3							
2							
1	(7)	(8)	(9)	△ (10)	(11)	(12)	(13)

LIST OF MATERIALS

SIZE	CAGE CODE	DWG NO	REV
A	22264 (5)	(1)	(3)
SCALE NONE (6)		UNIT WEIGHT (4)	SHEET 2 OF (2)

KSC FORM 21-2F NS (REV09/07) PREVIOUS EDITIONS ARE OBSOLETE

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Figure 13. Cable Subassembly Drawing – Materials List Page

D.2 Entry Descriptions For Cable Subassembly Drawing – Materials List Page

1. Drawing number.
2. Sheet number and total sheets in drawing (Notations for sheet number and total sheets shall comply with GP-435, Section 9.6. For multiple-sheet drawings, the total-sheet notation is required for only the first and last sheet [e.g., for a three-sheet drawing, the notations could read 1 of 3, 2, 2A, 2B, 3 of 3]).
3. Revision letter, if not the original drawing (e.g., A or B).
4. Unit weight – not applicable – leave blank.
5. Type cage number for KSC – 22264 (if not prefilled).
6. Scale – not applicable – leave blank.
7. List basic components in the following order starting in row 1(as needed):
   CABLE
   CONNECTOR (preferably End A with pin-type contacts)
   CONNECTOR (preferably End B with socket-type contacts)
   BACKSHELL (End A)
   BACKSHELL (End B, etc.)
   DUSTCAP (End A)
   DUSTCAP (End B, etc.)
   MOLD ADAPTER or BACKSHELL (End A)
   MOLD ADAPTER or BACKSHELL (End B, etc.)
   SHIELD RING (Inner)
   SHIELD RING (Outer)
   Whenever possible, use Qualified Products Lists (QPL) located in the NASA Standards and DSCC Web sites to select connectors, backshells, and dust caps. Use 75M13676, Table II, to select overall shield rings, and Table III to select shield rings for conductor sets.
8. Use MS, NASM, or NASA part numbers where possible. (Vendor part numbers are to be used only where MS and NASA specifications do not apply.)
9. Enter manufacturer's code for all vendor part numbers.
10. Enter quantity specified by the end of the cable on which it is used (e.g., 1 A or 1 B).
11. Enter information such as cable buildup (e.g., 4 (2#20PTSI) OSFBI, number of contacts (6 #20), I.D. for shield rings).
12. Enter applicable specifications, such as MIL-DTL-38999 or NASA-STD-8739.5.
13. Where substitutions may be made according to120E3100003, S1 through S18, enter the S number. If special notes are required, enter the number of the note located in the area above (20).
14. Put an X (if needed on both ends) by all bench stock materials needed. If needed on only one end, then specify end (e.g., A for end A or B for end B).
15. List all authorized substitution numbers (e.g., S3 or S11).

16. Place an X (for all ends), A (end A) or B (end B), etc., for all instructions of 120E3100003 that apply. Exception: Number 8: If 360° shield termination as illustrated in 120E3100003 does not apply, enter dash number of 79K04613. Number 1 will always have an X.
    (1) X
    (2) 75M13302 inspection
    (3) Dust caps
    (4) Mating connectors
    (5) Solder
    (6) Potting
    (7) Molding
    (8) 360° shield termination or dash number of 79K04613
    (9) Shield rings
    (10) Isolate shields
    (11) Barrier tape
    (12) Boots
    (13) Marker tape
    (14) Splicing instructions
    (15) Crimp contact terminations
17. Enter standard revision information.
    SYM – enter the revision letter (e.g., A or B).
    DESCRIPTION – enter a brief description of the changes made by the revision, including the sheet numbers and the change action applicable to each sheet (e.g., Deleted Pin Callout A or Added Shield Termination Pin AA).
    DATE – enter the date of the revision.
    APPROVAL – enter the signature, initials, name, or approval indicator of the responsible engineer or supervisor, and the materials and processes engineer authorized to approve the revision.
18. Draw a simple schematic that shows contact-to-contact wiring of cable between end connectors. Show all shielding and shield termination. If the schematic is too large or complicated for the space, use the A-size continuation sheet (KSC Form 21-2F), space 8.
19. If a continuation sheet is used, type: SEE SHEET 3 FOR WIRING SCHEMATIC.
20. Use this space for special notes, details, etc.

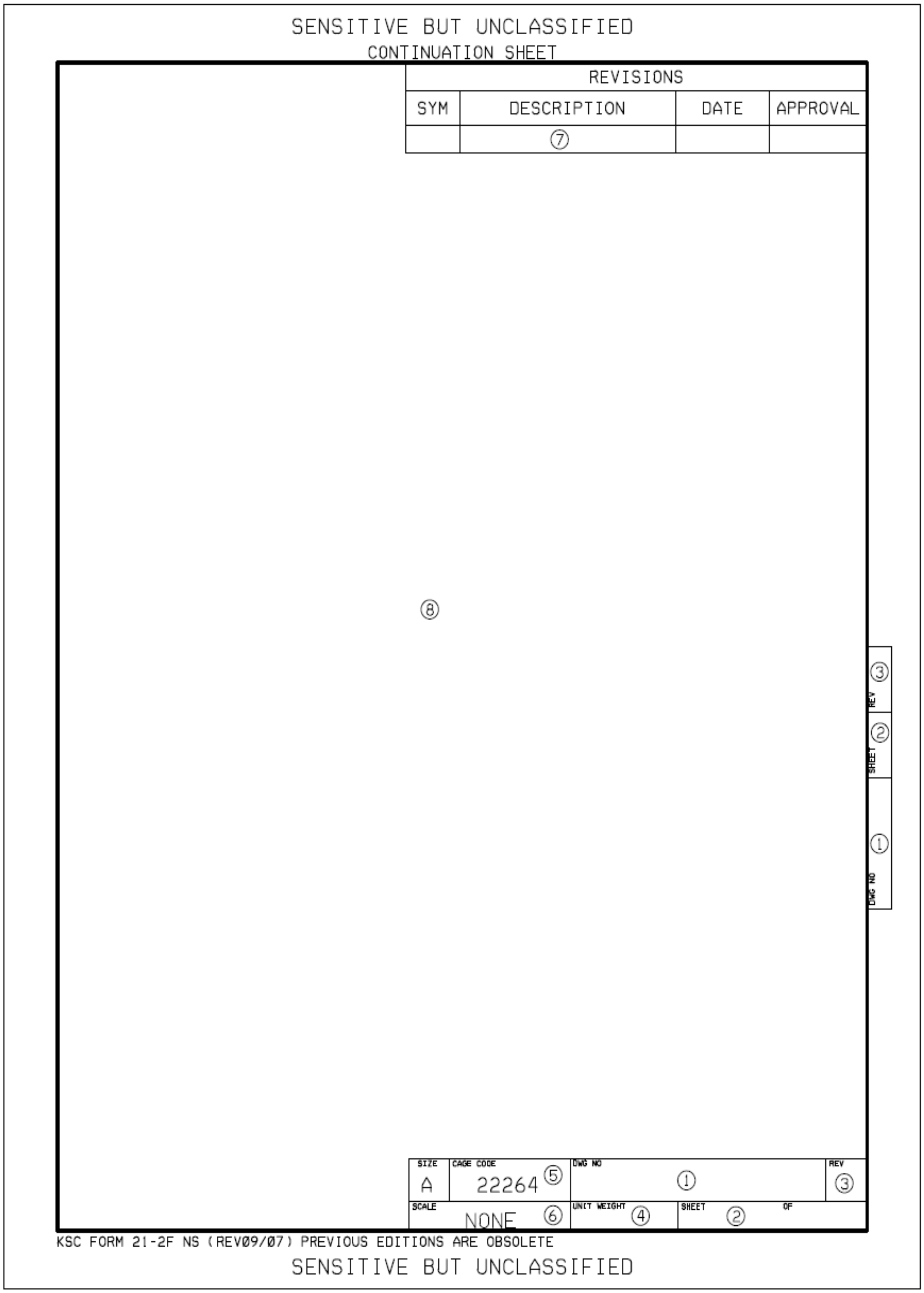

Figure 14. Cable Subassembly Drawing – Continuous/Last Page

D.3 Entry Descriptions For Cable Subassembly Drawing – Continuous/Last Page

1. Drawing number.
2. Sheet number and total sheets in drawing (e.g., 3 of 3).
3. Revision letter, if not the original drawing (e.g., A or B).
4. Unit weight – not applicable – leave blank.
5. Type cage number for KSC – 22264 (if not prefilled).
6. Scale – not applicable – leave blank.
7. Enter standard revision information:
   SYM – enter the revision letter (e.g., A or B)
   DESCRIPTION – enter a brief description of the changes made by the revision, including the sheet numbers and the change action applicable to each sheet (e.g., Deleted Pin Callout A, or Added Shield Termination Pin AA)
   DATE – enter the date of the revision
   APPROVAL – enter the signature, initials, name, or approval indicator of the responsible engineer or supervisor, and the materials and processes engineer authorized to approve the revision
8. Draw a simple schematic that shows contact-to-contact wiring of cable between end connectors. Show all shielding and shield terminations.

APPENDIX E. MIL-DTL-17 TABLE

M17 Part No.	M17 OPL	TMS Part No.	Conductor mm (inches)	Dielectric mm (inches)	Shields mm (inches)	Jacket mm (inches)	Armor mm (inches)	Weight kg/m (lb/ft)	Impedance ohms Vp (%)	Capacitance pF/m (pF/ft)	Max Oper. Voltage VRMS	Temp. Range °C (°F)	M17 Test Freq	Comments
M17/2-RG6	17-663-83	AA-3810	CCS 0.724 (0.0285)	PE 4.70 (0.185)	34SC-34BC 6.17 (0.243)	PVC-IIA 8.43 (0.332)	NA	0.122 (0.082)	75 ± 3 (66)	67.6 (20.6)	3,000	–40 +85 (–40 +185)	3 GHz, unswept	Use M17/180-00001 LS/LT jacket
M17/6-RG11	17-100-79	AA-3811	TC 7/.0159” 1.21 (0.0477)	PE 7.24 (0.285)	33BC 8.08 (0.318)	PVC-IIA 10.29 (0.405)	NA	0.146 (0.098)	75 ± 3 (66)	67.6 (20.8)	5,000	–40 +85 (–40 +185)	1 GHz, unswept	Use M17/181-00001 LS/LT jacket
M 17/6-RG12	17-100-79	AA-3812	TC 7/.0159” 1.21 (0.0477)	PE 7.24 (0.285)	33BC 8.08 (0.318)	PVC-IIA 10.29 (0.405)	Al Braid 11.76 (0.463)	0.200 (0.144)	75 ± 3 (66)	67.6 (20.6)	5,000	–40 +85 (–40 +185)	1 GHz, unswept	Use M17/181-00002 LS/LT jacket
M17/15-RG22	17-793-77	AA-3395	2-BC7/.0152” 1.16 (0.0456)	PE 7.24 (0.285)	34TC:34TC 8.71 (0.343)	PVC-IIA 10.67 (0.420)	NA	0.200 (0.134)	95 ± 5 (66)	52.5 (16.0)	1,000	–40 +85 (–40 +185)	200 MHz, unswept	Use M17/182-00001 LS/LT jacket
M17/15-RG111	17-793-77	AA-3396	2-BC 7/.0152” 1.16 (0.0456)	PE 7.24 (0.285)	34TC:34TC 8.71 (0.343)	PVC-IIA 10.67 (0.420)	Al Braid 12.14 (0.478)	0.240 (0.161)	95 ± 5 (66)	52.5 (16.0)	1,000	–40 +85 (–40 +185)	200 MHz, unswept	Use M17/182-00002 LS/LT jacket
M17/16-RG23	No QPL’d Source	AA-5160	2-BC 7/.0285” 2.175 (0.085)	PE: 2 cores 9.65 (0.380)	34BC:34BC 11.1×21.5 (0.438×0.847)	PVC-IIA 16.5 × 24.0 (650 × 0.945)	NA	0.789 (0.530)	125 ± 5 (66)	39.4 (12.0)	7,000	–40 +85 (–40 +185)	400 MHz, unswept	Inactive for new design
M17/16-RG24	No QPL’d Source	AA-5161	2-BC 7/.0285” 2.17 (0.0855)	PE: 2 cores 9.65 (0.380)	34BC:34BC 11.1×21.5 (.438×.847)	PVC-IIA 16.5× 4.0 (650×0.945)	Al Braid 18.0×25.5 (0.708×1.0 03)	1.087 (0.730)	125 ± 5 (66)	39.4 (12.0)	7,000	–40 +85 (–40 +185)	400 MHz, unswept	Inactive for new design
M17/19-RG25	No QPL’d Source	AA-5124	TC 19/.0117” 1.49 (0.0585)	Rubber-E 7.32 (0.288)	34TC-34TC 9.70 (0.382)	Rubber-IV 12.83 (0.505)	NA	0.335 (0.225)	48 ± 4 (42)	164.1 (50.0)	10,000	–55 +90 (–67 +194)	1 MHz, unswept	Triaxial pulse cable
M17/21-RG26	No QPL’d Source	AA-5125	TC 19/.0117” 1.49 (0.0585)	Rubber-E 7.32 (0.288)	34TC 8.05 (0.317)	Rubber-IV 10.80 (0.425)	Al Braid (12.83 0.505)	0.313 (0.210)	48 ± 4 (42)	164.1 (50.0)	10,000	–40 +85 (–40 +185)	1 MHz, unswept	Coaxial pulse cable, armored
M17/22-RG27	No QPL’d Source	AA-5163	TC 19/.0185” 2.35 (0.0925)	Rubber-D 11.56 (0.455)	34TC 12.29 (0.484)	Rubber-IV 15.11 (0.595)	Al Braid 17.02 (0.670)	0.492 (0.330)	48 ± 4 (42)	164.1 (50.0)	15,000	–40 +85 (–40 +185)	1 MHz, unswept	Coaxial pulse cable, armored
M17/22-00001	No QPL’d Source	AA-5162	TC 19/.0185” 2.35 (0.0925)	Rubber-D 11.56 (0.455)	34TC 15.11 (0.484)	Rubber-IV 15.11 (0.595)	NA	0.492 (0.330)	48 ± 4 (42)	164.1 (50.0)	15,000	–40 +85 (–40 +185)	1 MHz, unswept	Coaxial pulse cable
M17/23-RG28	No QPL’d Source	AA-5164	TC 19/.0185” 2.35 (0.0925)	Rubber-D 11.58 (0.455)	34TC:34GS 14.20 (0.559)	Rubber-IV 18.67 (0.735)	NA	164.1 (0.400)	48 ± 4 (42)	164.1 (50.0)	15,000	–40 +85 (–40 +185)	1 MHz, unswept	Triaxial pulse cable
M17/24-RG34	No QPL’d Source	AA-3813	TC 7/.0249” 1.90 (0.0747)	PE 11.68 (0.460)	33BC 12.52 (0.493)	PVC-IIA 16.00 (0.630)	NA	0.344 (0.231)	75 ± 3 (66)	72.2 (22.0)	6,500	–40 +85 (–40 +185)	1 GHz, unswept	
M17/28-RG58	17-304-83	AA-3397	TC 19/.0072” 0.090 (0.0355)	PE 2.95 (0.116)	36TC 3.53 (0.139)	PVC-IIA 4.95 (0.195)	NA	0.039 (0.026)	50 ± 2 (66)	101.1 (30.8)	1,900	–40 +85 (–40 +185)	0.05 to 1 GHz, swept	Use M17/183-00001 LS/LT jacket
M17/29-RG59	17-102-79	AA-3797	CCS 0.57 (0.0226)	PE 3.71 (0.146)	34BC 4.45 (0.175)	PVC-IIA 6.15 (0.242)	NA	0.052 (0.035)	75 ± 3 (66)	67.6 (20.6)	2,300	–40 +85 (–40 +185)	1 GHz, unswept	Use M17/184-00001 LS/LT jacket

M17 Part No.	M17 OPL	TMS Part No.	Conductor mm (inches)	Dielectric mm (inches)	Shields mm (inches)	Jacket mm (inches)	Armor mm (inches)	Weight kg/m (lb/ft)	Impedance ohms Vp (%)	Capacitance pF/m (pF/ft)	Max Oper. Voltage VRMS	Temp. Range °C (°F)	M17 Test Freq	Comments
M17/30-RG62	17-795-77	AA-3398	CCS 0.64 (0.0253)	Airspaced PE 3.71 (0.146)	34BC 4.45 (0.175)	PVC-IIA 6.15 (0.242)	NA	0.057 (0.038)	93 ± 5 (81)	44.3 (13.5)	1,000	–40 +80 (–40 +176)	1 GHz, unswept	Use M17/185-00001 LS/LT jacket
M17/31-RG63	17-103-79	AA-3815	CCS 0.64 (0.0253)	Airspaced PE 7.24 (0.285)	33BC 8.08 (0.318)	PVC-IIA 10.29 (0.405)	NA	0.206 (0.138)	125 ± 6 (86)	36.1 (11.0)	750	–40 +80 (–40 +176)	1 GHz, unswept	Use M17/218-00001 LS/LT jacket
M17/31-RG79	17-103-79	AA-3816	CCS 0.64 (0.0253)	Airspaced PE 7.24 (0.285)	33BC 8.08 (0.318)	PVC-IIA 10.29 (0.405)	Al Braid 12.07 (0.475)	0.131 (0.088)	125 ± 5 (81)	32.8 (10.0)	1,000	–40 +80 (–40 +175)	1 GHz, unswept	Use M17/218-00002 LS/LT jacket
M17/33-RG64	No QLP'd Source	AA-5126	TC 19/.0117" 1.49 (0.0585)	Rubber-E 7.32 (0.288)	34TC:34TC 8.79 (0.346)	Rubber-IV 11.68 (0.450)	NA	0.328 (0.220)	48 ± 4 (42)	180.5 (55.0)	10,000	–40 +85 (–40 +185)	1 MHz, unswept	Coaxial pulse cable
M17/34-RG65	No QLP'd Source	AA-5165	.008" MW Helix 3.25 (0.1280)	PE 7.24 (0.285)	33BC 8.08 (0.318)	PVC-IIA 10.29 (0.405)	NA	0.164 (0.110)	950 ± 50 (2)	157.5 (48.0)	1,500	–40 +80 (–40 +176)	5 MHz, unswept	Coaxial delay line, 0.15 µs/ft
M17/45-RG108	17-796-77	AA-3399	2:TC 7/.0126" 0.96 (0.0378)	PE (2 cores) 2.01 (0.079)	36TC 4.60 (0.181)	PVC-IIA 5.97 (0.235)	NA	0.052 (0.035)	78 ± 7 (68)	64.3 (19.6)	1,000	–40 +85 (–40 +185)	10 MHz, unswept	Use M17/186-00001 LS/LT jacket
M17/47-RG114	Non-QPL'd	AA-3817	CCS 0.18 (0.007)	Airspaced PE 7.24 (0.285)	34BC 7.98 (0.314)	PVC-IIA 10.29 (0.405)	NA	1.33 (0.089)	185 ± 10 (85)	21.3 (6.5)	1,000	–40 +80 (–40 +176)	1 GHz, unswept	Use M17/208-00001 LS/LT jacket
M17/52-RG119	17-749-85	AA-3818	BC 2.59 (0.1019)	PTFE 8.43 (0.332)	33BC:34BC 10.01 (0.394)	FG Braid-V 11.81 (0.465)	NA	0.340 (0.228)	50 ± 2 (69.5)	96.5 (29.4)	6,000	–55 +200 (–67 +392)	0.05 to 1 GHz, swept	High-power coax
M17/52-RG120	17-749-85	AA-3819	BC 2.59 (0.1019)	PTFE 8.43 (0.332)	33BC:34BC 10.01 (0.394)	FG Braid-V 11.81 (0.465)	Al Braid 13.34 (0.525)	0.426 (0.286)	50 ± 2 (69.5)	96.5 (29.4)	6,000	–55 +200 (–67 +392)	0.05 to 1 GHz, swept	Armored M17/52-RG119
M17/52-00001	No QPL'd Source	NA	BC 2.59 (0.1019)	PTFE 8.43 (0.332)	33SC:33SC 10.01 (0.394)	FG Braid-V 11.81 (0.465)	NA	0.340 (0.228)	50 ± 2 (69.5)	96.5 (29.4)	6,000	–55 +200 (–67 +392)	0.05 to 3 GHz, swept	High-frequency M17/52-RG119
M17/54-RG122	17-305-83	AA-3400	TC 27/.005" 0.78 (0.0308)	PE 2.44 (0.096)	36TC 3.02 (0.119)	PVC-IIA 4.06 (0.160)	NA	0.031 (0.021)	50 ± 2 (66)	101.1 (30.8)	1,900	–40 +85 (–40 +185)	0.05 to 1 GHz, swept	Use M17/187-00001 LS/LT jacket
M17/56-RG130	No QPL'd Source	AA-5166	2:BC 7/.0285" 2.17 (0.0855)	PE 11.99 (0.472)	30TC 13.16 (0.518)	PVC-IIA 15.88 (0.625)	NA	0.447 (0.300)	95 ± 5 (66)	53.5 (16.3)	3,000	–40 +85 (–40 +185)	200 MHz, unswept	Balanced shielded line
M17/56-RG131	No QPL'd Source	AA-5187	2:BC 7/.0285" 2.17 (0.0855)	PE 11.99 (0.472)	30TC 13.16 (0.518)	PVC-IIA 15.88 (0.625)	Al Braid 18.03 (0.710)	0.596 (0.400)	95 ± 5 (66)	53.5 (16.3)	3,000	–40 +85 (–40 +185)	200 MHz, unswept	Armored M17/56-RG130
M17/60-RG142	17-664-83	AA-3401	SCCS 0.94 (0.037)	PTFE 2.95 (0.116)	36SC: 36SC 4.11 (0.162)	FEP-IX 4.95 (0.195)	NA	0.064 (0.043)	50 ± 2 (69.5)	96.5 (29.4)	1,900	–55 +200 (–67 +392)	0.05 to 8 GHz, swept	50-ohm, low-loss, high-temperature coax
M17/62-RG144	17-750-85	AA-3820	SCCS 7/.0175" 1.33 (0.0525)	PTFE 7.24 (0.285)	34SC 7.98 (0.314)	FG Braided-V 10.41 (0.410)	NA	0.209 (0.140)	75 ± 3 (69.5)	64.0 (19.5)	5,000	–55 +200 (–67 +392)	3 GHz, unswept	75-ohm, low-loss, high-temperature coax
M17/64-RG35	No QPL'd Source	AA-3822	BC 2.65 (0.1045)	PE 17.27 (0.680)	30BC 18.44 (0.726)	PVC-IIA 22.10 (0.870)	Al Braid 24.00 (0.945)	0.812 (0.545)	75 ± 3 (66)	67.6 (20.6)	10,000	–40 +85 (–40 +185)	1 GHz, unswept	Armored M17/209-00001
M17/64-RG164	No QPL'd Source	AA-3821	BC 2.65 (0.1045)	PE 17.27 (0.680)	30BC 18.44 (0.726)	PVC-IIA 22.10 (0.870)	NA	0.752 (0.505)	75 ± 3 (66)	67.6 (20.6)	10,000	–40 +85 (–40 +185)	1 GHz, unswept	Use M17/209-0001 LS/LT jacket

M17 Part No.	M17 OPL	TMS Part No.	Conductor mm (inches)	Dielectric mm (inches)	Shields mm (inches)	Jacket mm (inches)	Armor mm (inches)	Weight kg/m (lb/ft)	Impedance ohms Vp (%)	Capacitance pF/m (pF/ft)	Max Oper. Voltage VRMS	Temp. Range °C (°F)	M17 Test Freq	Comments
M17/65-RG165	17-598-81	AA-3402	SC 7/.0315" 2.39 (0.094)	PTFE 7.24 (0.285)	34SC 7.98 (0.314)	FG Braid-V 10.41 (0.410)	NA	0.212 (0.142)	50 ± 2 (69.5)	96.5 (29.4)	2,500	–55 +250 (–67 +482)	00.05 to 3 GHz, swept	
M17/65-RG166	17-598-81	AA-3403	SC 7/.0315" 2.39 (0.094)	PTFE 7.24 (0.285)	34SC 7.98 (0.314)	FG Braid-V 10.41 (0.410)	Al Braid 11.94 (0.470)	0.282 (0.189)	50 ± 2 (69.5)	96.5 (29.4)	2,500	–55 +250 (–67 +482)	0.05 to 3 GHz, swept	Armored M17/65-RG165
M17/67-RG177	17-1102-85	AA-3404	BC 4.95 (0.195)	PE 17.27 (0.680)	34SC: 34SC 18.75 (0.738)	PVC-IIA 22.73 (0.895)	NA	0.775 (0.520)	50 ± 2 (66)	101.1 (30.8)	11,000	–40 +85 (–40 +185)	0.05 to 3 GHz, swept	Use M17/210-00001 LS/LT jacket
M17/72-RG211	No QPL'd Source	AA-3405	BC 4.88 (0.192)	PTFE 15.75 (0.620)	32BC 16.69 (0.657)	FG Braid-V 18.54 (0.730)	NA	0.769 (0.516)	50 ± 2 (69.5)	96.5 (29.4)	7,000	–55 +250 (–67 +482)	0.05 to 3 GHz, swept	
M17/73-RG212	17-1104-85	AA-3406	SC 1.41 (0.0556)	PE 4.70 (0.185)	34SC:34SC 6.17 (0.243)	PVC-IIA 8.43 (0.332)	NA	0.133 (0.089)	50 ± 2 (66)	101.1 (30.8)	3,000	–40 +85 (–40 +185)	0.05 to 3 GHz, swept	Use M17/188-00001 LS/LT jacket
M17/74-RG213	17-804-77	AA-3408	BC 7/.0296" 2.26 (0.0888)	PE 7.24 (0.285)	33BC 8.08 (0.318)	PVC-IIA 10.29 (0.405)	NA	0.165 (0.111)	50 ± 2 (66)	101.1 (30.8)	5,000	–40 +85 (–40 +185)	0.05 to 1 GHz, swept	Use M/17189-00001 LS/LT jacket
M17/74-RG215	17-804-77	AA-3407	BC 7/.0296" 2.26 (0.0888)	PE 7.24 (0.285)	33BC 8.08 (0.318)	PVC-IIA 10.29 (0.405)	Al Braid 12.07 (0.475)	0.206 (0.138)	50 ± 2 (66)	101.1 (30.8)	5,000	–40 +85 (–40 +185)	0.05 to 11 GHz, swept	Use M17/189-00002 LS/LT jacket
M17/75-RG214	17-804-77	AA-3409	SC 7/.0296" (2.26 0.0888)	PE 7.24 (0.285)	34SC:34SC 8.71 (0.343)	PVC-IIA 10.80 (0.425)	NA	0.194 (0.130)	50 ± 2 (66)	101.1 (30.8)	5,000	–40 +85 (–40 +185)	0.05 to 11 GHz, swept	Use M17/190-00001 LS/LT jacket
M17/75-RG365	17-984-85	AA-4761	SC 7/.0296" 2.26 (0.0888)	PE 7.24 (0.285)	34SC:34SC 8.71 (0.343)	TPE 10.80 (0.425)	NA	0.194 (0.130)	50 ± 2 (66)	101.1 (30.8)	5,000	–55 +85 (–67 +185)	0.05 to 11 GHz, swept	
M17/77-RG216	17-108-79	AA-3823	TC 7/.0159" 1.21 (0.0477)	PE 7.24 (0.285)	34BC:34BC 8.71 (0.343)	PVC-IIA 10.80 (0.425)	NA	0.185 (0.124)	75 ± 3 (66)	67.6 (20.6)	5,000	–40 +85 (–40 +185)	3 GHz, unswept	Use M17/191-00001 LS/LT jacket
M17/78-RG217	17-1102-85	AA-3410	BC 2.69 (0.106)	PE 9.40 (0.370)	33BC:33BC 11.07 (0.436)	PVC-IIA 13.84 (0.545)	NA	0.335 (0.225)	50 ± 2 (66)	101.1 (30.8)	7,000	–40 +85 (–40 +185)	0.05 to 3 GHz, swept	Use M17-192-00001 LS/LT jacket
M17/78-00001	17-1102-85	AA-8212	BC 2.69 (0.106)	PE 9.40 (0.370)	33BC:33BC 12.07 (0.436)	PVC-IIA 13.84 (0.545)	NA	0.335 (0.225)	50 ± 2 (66)	101.1 (30.8)	7,000	–40 +80 (–40 +176)	0.05 to 3 GHz, swept	Temperature-cycled M17/78-RG217
M17/79-RG218	17-1102-85	AA-3411	BC 4.95 (0.195)	PE 17.27 (0.680)	30BC 18.44 (0.726)	PVC-IIA 22.10 (0.870)	NA	0.760 (0.510)	50 ± 2 (66)	101.1 (30.8)	11,000	–40 +85 (–40 +185)	0.05 to 1 GHz, swept	Use M17/193-00001 LS/LT jacket
M17/79-RG219	17-1102-85	AA-3412	BC 4.95 (0.195)	PE 17.27 (0.680)	30BC 18.44 (0.726)	PVC-IIA 22.10 (0.870)	Al Braid 24.00 (0.945)	0.819 (0.550)	50 ± 2 (66)	101.1 (30.8)	11,000	–40 +85 (–40 +185)	0.05 to 1 GHz, swept	Use M17/193-00002 LS/LT jacket
M17/81-00001	17-354-88	AA-6002	BC 6.60 (0.260)	PE 23.11 (0.910)	30BC 24.2 (0.9568)	PVC-IIA 28.45 (1.120)	NA	1.221 (0.820)	50 ± 2 (66)	101.1 (30.8)	14,000	–40 +85 (–40 +185)	1 GHz, unswept	
M17/81-00002	17-354-88	AA-6003	BC 6.60 (0.260)	PE 23.11 (0.910)	30BC 24.2 (0.9568)	PVC-IIA 28.45 (1.120)	Al Braid 30.35 (1.195)	1.311 (0.880)	50 ± 2 (66)	101.1 (30.8)	14,000	–40 +85 (–40 +185)	1 GHz, unswept	Armored M17/81-00001
M17/84-RG223	17-303-83	AA-3413	SC 0.89 (0.035)	PE 2.95 (0.116)	36SC:36SC 4.11 (0.162)	PVC-IIA 5.38 (0.212)	NA	0.061 (0.041)	50 ± 2 (66)	101.1 (30.8)	1,900	–40 +85 (–40 +185)	0.04 to 12.4 GHz, swept	Use M17/194-00001 LS/LT jacket

M17 Part No.	M17 OPL	TMS Part No.	Conductor mm (inches)	Dielectric mm (inches)	Shields mm (inches)	Jacket mm (inches)	Armor mm (inches)	Weight kg/m (lb/ft)	Impedance ohms Vp (%)	Capacitance pF/m (pF/ft)	Max Oper. Voltage VRMS	Temp. Range °C (°F)	M17 Test Freq	Comments
M17/86-00001	17-598-81	AA-5077	SC 7/.0312" 2.38 (0.0936)	PTFE 7.24 (0.285)	34SC:34SC 8.71 (0.343)	FG Braid-V 10.92 (0.430)	NA	0.290 (0.195)	50 ± 2 (69.5)	96.5 (29.4)	5,000	–55 +200 (–67 +392)	400 MHz, unswept	
M17/86-00002	17-598-81	AA-5078	SC 7/.0312" 2.38 (0.0936)	PTFE 7.24 (0.285)	34SC:34SC 8.71 (0.343)	FG Braid-V 10.92 (0.430)	Al Braid 12.45 (0.490)	0.331 (0.222)	50 ± 2 (69.5)	96.5 (29.4)	5,000	–55 +200 (–67 +392)	400 MHz, unswept	Armored M17/86-00001
M17/87-00001	17-355-88	AA-5168	SC 19/.0254" 3.23 (0.127)	Taped PTFE 9.40 (0.370)	34BC:34SC 5.03 (0.198)	FG Braid-V 12.70 (0.500)	NA	0.667 (0.448)	50 ± 2 (71)	95.1 (29.0)	7,000	–55 +200 (–67 +392)	400 MHz, unswept	
M17/90-RG71	17-280-83	AA-4444	CCS 0.54 (0.0253)	Airspace PE 3.71 (0.146)	34BC:36TC 5.03 (0.198)	PE-IIIA 6.22 (0.245)	NA	0.074 (0.050)	93 ± 5 (81)	44.3 (13.5)	1,000	–55 +85 (–67 +185)	1 GHz, unswept	Use M17/195-00001 LS/LT jacket
M17/92-RG115	17-598-81	AA-3824	SC 7/.0280" 2.13 (0.084)	Taped PTFE 6.48 (0.255)	34SC:34SC 7.95 (0.313)	FG Braid-V 10.54 (0.415)	NA	0.276 (0.185)	50 ± 2 (71)	95.1 (29.0)	5,000	–55 +200 (–67 +392)	0.05 to 12.4 GHz, swept	
M17/92-00001	17-598-81	AA-5308	SC 7/.0280" 2.13 (0.084)	Taped PTFE 6.48 (0.255)	34SC:34SC 7.95 (0.313)	FEP-IX 8.74 (0.344)	NA	0.276 (0.185)	50 ± 2 (71)	95.1 (29.0)	5,000	–55 +200 (–67 +392)	0.05 to 12.4 GHz, swept	
M17/93-RG178	17-666-83	AA-3414	SCCS 7/.0040" 0.30 (0.012)	PTFE 0.84 (0.033)	38SC 1.30 (0.051)	FEP-IX 1.80 (0.071)	NA	0.009 (0.006)	50 ± 2 (69.5)	96.5 (29.4)	1,000	–55 +200 (–67 +392)	0.05 to 3 GHz, swept	
M17/93-00001	17-867-84	AA-4762	SCCS 7/.0040" 0.30 (0.012)	PTFE 0.84 (0.033)	38SC 1.30 (0.051)	PFA-XIII 1.80 (0.071)	NA	0.009 (0.006)	50 ± 2 (69.5)	96.5 (29.4)	1,000	–55 +230 (–67 +446)	0.05 to 3 GHz, swept	
M17/94-RG179	17-809-77	AA-3415	SCCS 7/.0040" 0.30 (0.012)	PTFE 1.60 (0.063)	38SC 2.06 (0.081)	FEP-IX 2.54 (0.100)	NA	0.015 (0.010)	75 ± 3 (69.5)	64.0 (19.5)	1,200	–55 +200 (–67 +392)	3 GHz, unswept	
M17/95-RG180	17-810-77	AA-3416	SCCS 7/.0040" 0.30 (0.012)	PTFE 2.59 (0.102)	38SC 3.05 (0.120)	FEP-IX 3.58 (0.141)	NA	0.029 (0.0198)	95 ± 5 (69.5)	50.5 (15.4)	1,500	–55 +200 (–67 +392)	3 GHz, unswept	
M17/97-RG210	17-668-83	AA-4763	SCCS 0.64 (0.0253)	Airspace PE 3.71 (0.146)	34SC 4.45 (0.175)	FG Braid-V 6.15 (0.242)	NA	0.074 (0.050)	93 ± 5 (85)	44.3 (13.5)	1,000	–55 +200 (–67 +392)	3 GHz, unswept	
M17/100-RG133	No QPL'd Source	NA	BC 0.64 (0.0253)	PE 7.24 (0.285)	33BC 8.08 (0.318)	PVC-IIA 10.29 (0.405)	NA	0.142 (0.095)	95 ± 5 (66)	53.5 (16.3)	5,000	–40 +85 (–40 +185)	1 GHz, unswept	
M17/109-RG301	No QPL'd Source	NA	HR 7/.0203" 1.55 (0.0609)	PTFE 4.70 (0.185)	36HR 5.28 (0.208)	FEP-IX 6.22 (0.245)	NA	0.083 (0.056)	50 ± 2 (69.5)	96.5 (29.4)	3,000	–55 +200 (–67 +392)	3 GHz, unswept	
M17/110-RG302	17-425-84	AA-3826	SCCS 0.64 (0.0253)	PTFE 3.71 (0.146)	36SC 4.29 (0.169)	FEP-IX 5.13 (0.202)	NA	0.060 (0.040)	75 ± 3 (69.5)	64.0 (19.5)	2,300	–55 +200 (–67 +392)	3 GHz, unswept	
M17/111-RG303	17-811-77	AA-3417	SCCS 0.94 (0.0370)	PTFE 2.95 (0.116)	36SC 3.53 (0.139)	FEP-IX 4.32 (0.170)	NA	0.046 (0.031)	50 ± 2 (69.5)	96.5 (29.4)	1,900	–55 +200 (–67 +392)	0.05 to 3 GHz, swept	
M17/112-RG304	17-474-86	AA-5130	SCCS 1.50 (0.0590)	PTFE 4.70 (0.185)	34SC:34SC 6.17 (0.243)	FEP-IX 7.11 (0.280)	NA	0.140 (0.094)	50 ± 2 (69.5)	96.5 (29.4)	3,000	–55 +200 (–67 +392)	0.05 to 8 GHz, swept	
M17/113-RG316	17-812-77	AA-3418	SCCS 7/.0067" 0.51 (0.0201)	PTFE 1.52 (0.060)	38SC 1.98 (0.078)	FEP-IX 2.49 (0.098)	NA	0.018 (0.012)	50 ± 2 (69.5)	96.5 (29.4)	1,200	–55 +200 (–67 +392)	0.05 to 3 GHz, swept	

M17 Part No.	M17 OPL	TMS Part No.	Conductor mm (inches)	Dielectric mm (inches)	Shields mm (inches)	Jacket mm (inches)	Armor mm (inches)	Weight kg/m (lb/ft)	Impedance ohms Vp (%)	Capacitance pF/m (pF/ft)	Max Oper. Voltage VRMS	Temp. Range °C (°F)	M17 Test Freq	Comments
M17/116-RG307	17-482-84	AA-4346	SC 19/.0058" 0.74 (0.0290)	Foam PE 3.71 (0.146)	34SC-PUR-34SC 5.94 (0.234)	PE-IIIA 6.73 (0.265)	NA	0.119 (0.080)	75 ± 3 (81)	55.4 (16.9)	1,000	–55 +85 (–67 +185)	1 GHz, unswept	
M17/119-RG174	17-813-77	AA-3419	CCS 7/.0063" 0.48 (0.0189)	PE 1.52 (0.060)	38TC 1.98 (0.078)	PVC-IIA 2.79 (0.110)	NA	0.013 (0.009)	50 ± 2 (66)	101.1 (30.8)	1,500	–40 +85 (–40 +185)	0.05 to 1 GHz, swept	Use M17/196-00001 LS/LT jacket
M17/124-RG328	No QPL'd Source	NA	TC Braid 12.32 (0.4850)	Rubber H,J,H 27.05 (1.065)	30TC: 33GS:30TC 31.78 (1.251)	Neoprene 37.08 (1.460)	NA	2.383 (1.600)	25 ± 2 (48)	278.9 (85.0)	15,000	–55 +85 (–67 +185)	1 GHz, unswept	
M17/125-RG329	No QPL'd Source	NA	TC19/.0117" 1.49 (0.0585)	Rubber H,J,H 9.65 (0.380)	30TC: 33GS:30TC 14.50 (0.571)	Neoprene 17.78 (0.700)	NA	0.526 (0.353)	50 ± 2 (43)	164.1 (50.0)	15,000	–55 +90 (–67 +194)	1 GHz, unswept	
M17/126-RG391	17-670-83	AA-4464	TC 7/.0159" 1.21 (0.0477)	CPE & PE 7.49 (0.295)	34TC 8.23 (0.324)	PVC-IIA 10.29 (0.405)	NA	0.149 (0.100)	72 ± 3 (64)	75.5 (23.0)	5,000	–40 +85 (–40 +185)	1 GHz, unswept	Use: M17/211-00001 LS/LT jacket
M17/126-RG392	17-670-83	AA-4465	TC 7/.0159" 1.21 (0.0477)	CPE & PE 7.49 (0.295)	34TC 8.23 (0.324)	PVC-IIA 10.29 (0.405)	Al Braid 12.07 (0.475)	0.186 (0.125)	72 ± 3 (64)	75.5 (23.0)	5,000	–40 +85 (–40 +185)	1 GHz, unswept	Armored M17/211-00001
M17/127-RG393	17-429-84	AA-3420	SC 7/.0312" 2.39 (0.094)	PTFE 7.24 (0.285)	34SC:34SC 8.71 (0.343)	FEP-IX 9.91 (0.390)	NA	0.261 (0.175)	50 ± 2 (69.5)	96.5 (29.4)	2,500	–55 +200 (–67 +392)	0.05 to 11 GHz, swept	
M17/128-RG400	17-671-83	AA-3827	SC 19/.0080" 0.98 (0.0384)	PTFE 2.95 (0.116)	36SC:36SC 4.11 (0.162)	FEP-IX 4.95 (0.195)	NA	0.074 (0.050)	50 ± 2 (69.5)	96.5 (29.4)	1,900	–55 +200 (–67 +392)	0.05 to 12.4 GHz, swept	
M17/129-RG401	17-197-85	AA-5011	SC 1.63 (0.0641)	PTFE 5.31 (0.209)	BC Tube 6.35 (0.250)	None	NA	0.156 (0.105)	50 ± 0.5 (69.5)	96.5 (29.4)	3,000	–40 +90 (–40 +194)	0.4 to 18 GHz, swept	
M17/129-00001	17-197-85	AA-5012	SC 1.63 (0.0641)	PTFE 5.31 (0.209)	TC Tube 6.35 (0.250)	None		0.158 (0.106)	50 ± 0.5 (69.5)	96.5 (29.4)	3,000	–40 +90 (–40 +194)	0.4 to 18 GHz, swept	Tin-plated M17/129-RG401
M17/130-RG402	17-197-85	AA-5013	SCCS 0.92 (0.0362)	PTFE 2.98 (0.1175)	BC Tube 3.58 (0.141)	None	NA	0.051 (0.0344)	50 ± 2 (69.5)	96.5 (29.4)	1,900	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	
M17/130-00001	17-197-85	AA-5014	SCCS 0.92 (0.0362)	PTFE 2.98 (0.1175)	TC Tube 3.58 (0.141)	None	NA	0.052 (0.0351)	50 ± 1 (69.5)	96.5 (29.4)	1,900	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	Tin-plated M17/130-RG402
M17/130-00002	17-197-85	AA-5015	SNCCS 0.92 (0.0362)	PTFE 2.98 (0.1175)	BC Tube 3.58 (0.141)	None	NA	0.051 (0.0344)	50 ± 1 (69.5)	96.5 (29.4)	1,900	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	
M17/130-00003	17-197-85	AA-5016	SNCCS 0.92 (0.0362)	PTFE 2.98 (0.1175)	TC Tube 3.58 (0.141)	None	NA	0.052 (0.0351)	50 ± 1 (69.5)	96.5 (29.4)	1,900	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	Tin-plated M17/130-00002
M17130-00004	17-297-90	AA-5916	SCCS 0.92 (0.0362)	PTFE 2.98 (0.1175)	BC Tube 3.58 (0.141)	None	NA	0.051 (0.0344)	50 ± 1 (69.5)	96.5 (29.4)	1,900	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	
M17/130-00005	17-297-90	AA-5917	SCCS 0.92 (0.0362)	PTFE 2.98 (0.1175)	TC Tube 3.58 (0.141)	None	NA	0.052 (0.0351)	50 ± 1 (69.5)	96.5 (29.4)	1,900	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	Tin-plated M17/130-00004

M17 Part No.	M17 OPL	TMS Part No.	Conductor mm (inches)	Dielectric mm (inches)	Shields mm (inches)	Jacket mm (inches)	Armor mm (inches)	Weight kg/m (lb/ft)	Impedance ohms Vp (%)	Capacitance pF/m (pF/ft)	Max Oper. Voltage VRMS	Temp. Range °C (°F)	M17 Test Freq	Comments
M17/130-00006	17-297-90	AA-5918	SNCCS 0.92 (0.0362)	PTFE 2.98 (0.1175)	BC Tube 3.58 (0.141)	None	NA	0.051 (0.0344)	50 ± 1 (69.5)	96.5 (29.4)	1,900	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	
M17/130-00007	17-297-90	AA-5919	SNCCS 0.92 (0.0362)	PTFE 2.98 (0.1175)	TC Tube 3.58 (0.141)	None	NA	0.052 (0.0351)	50 ± 1 (69.5)	96.5 (29.4)	1,900	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	Tin-plated M17/130-00006
M17/130-00008	Non-QPL'd	NA	SCCS 0.92 (0.0362)	PTFE 2.98 (0.1175)	Al Tube 3.58 (0.141)	None	NA	0.028 (0.0188)	50 ± 1 (69.5)	98.1 (29.9)	1,900	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	
M17/130-00009	Non-QPL'd	NA	SCCS 0.92 (0.0362)	PTFE 2.98 (0.1175)	Tinned Al Tube 3.58 (0.141)	None	NA	0.031 (0.0205)	50 ± 1 (69.5)	98.1 (29.9)	1,900	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	Tin-plated M17/130-00008
M17/130-00010	No QPL'd Source	NA	SNCCS 0.92 (0.0362)	PTFE 2.98 (0.1175)	Al Tube 3.58 (0.141)	None	NA	0.028 (0.0188)	50 ± 1 (9.5)	98.1 (29.9)	1,900	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	
M17/130-00011	No QPL'd Source	NA	SNCCS 0.92 (0.0362)	PTFE 2.98 (0.1175)	Tinned Al Tube 3.58 (0.141)	None	NA	0.031 (0.0205)	50 ± 1 (69.5)	98.1 (29.9)	1,900	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	Tin-plated M17/130-00010
M17/130-00012	Non-QPL'd	NA	SCCS 0.92 (0.0362)	PTFE 2.98 (0.1175)	SC Tube 3.58 (0.141)	None	NA	0.052 (0.0351)	50 ± 1 (69.5)	98.1 (29.9)	1,900	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	Silver-plated M17/130-00004
M17/130-00013	No QPL'd Source	NA	SNCCS 0.92 (0.0362)	PTFE 2.98 (0.1175)	SC Tube 3.58 (0.141)	None	NA	0.052 (0.0351)	50 ± 1 (69.5)	98.1 (29.9)	1,900	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	Silver-plated M17/130-00006
M17/130-00014	No QPL'd Source	NA	SCCS 0.92 (0.0362)	PTFE 2.98 (0.1175)	TC Tube 3.58 (0.141)	None	NA	0.052 (0.0351)	50 ± 1 (69.5)	98.1 (29.9)	1,900	–40 +125 (–40 +257)	0.5 to 20 GHz	90/10 tin-plated, 300 microinches minimum
M17/130-00015	No QPL'd Source	NA	SC 0.92 (0.0362)	PTFE 2.98 (0.1175)	TC Tube 3.58 (0.141)	None	NA	0.052 (0.0351)	50 ± 1 (69.5)	98.1 (29.9)	1,900	–40 +125 (–40 +257)	0.5 to 20 GHz	90/10 tin-plated, 300 microinches minimum
M17/131-RG403	17-244-90	AA-6511	SCCS 7/.004 0.30 (0.0120)	PTFE 0.84 (30.033)	8SC-FEP-38SC 2.24 (0.088)	FEP-IX 2.95 (0.116)	NA	0.022 (0.015)	50 ± 2 (69.5)	96.5 (29.4)	1,000	–55 +200 (–67 +392)	0.05 to 10 GHz, swept	RG-178, triax
M17/132-00001	17-245-90	AA-6512	SCCS 7/.004 0.30 (0.0120)	PTFE & CPT 0.91 (0.035)	38SC 1.37 (0.054)	FEP-IX 1.80 (0.071)	NA	0.027 (0.018)	50 ± 2 (68)	99.7 (30.4)	1,000	–40 +200 (–40 +392)	1 GHz, unswept	RG-178, low-noise
M17/133-RG405	17-197-85	AA-5017	SCCS 0.51 (0.0201)	PTFE 1.68 (0.065)	BC Tube 2.20 (0.0865)	None	NA	0.023 (0.0153)	50 ± 1.5 (69.5)	96.5 (29.4)	1,500	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	
M17/133-00001	17-197-85	AA-5018	SCCS 0.51 (0.0201)	PTFE 1.68 (0.066)	TC Tube 2.20 (0.0865)	None	NA	0.024 (0.0158)	50 ± 1.5 (69.5)	96.5 (29.4)	1,500	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	Tin-plated M17/133-RG405
M17/133-00002	17-298-90	AA-5019	SC 0.51 (0.0201)	PTFE 1.68 (0.066)	BC Tube 2.20 (0.0865)	None	NA	0.023 (0.0152)	50 ± 1.5 (69.5)	96.5 (29.4)	1,500	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	
M17/133-00003	17-298-90	AA-5020	SC 0.51 (0.0201)	PTFE 1.68 (0.066)	TC Tube 2.20 (0.0865)	None	NA	0.023 (0.0157)	50 ± 1.5 (69.5)	96.5 (29.4)	1,500	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	Tin-plated M17/133-00002
M17/133-00004	17-298-90	AA-5021	SNCCS 0.51 (0.0201)	PTFE 1.68 (0.066) (1.68)	BC Tube 2.20 (0.0865)	None	NA	0.023 (0.0154)	50 ± 1.5 (69.5)	96.5 (29.4)	1,500	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	

M17 Part No.	M17 OPL	TMS Part No.	Conductor mm (inches)	Dielectric mm (inches)	Shields mm (inches)	Jacket mm (inches)	Armor mm (inches)	Weight kg/m (lb/ft)	Impedance ohms Vp (%)	Capacitance pF/m (pF/ft)	Max Oper. Voltage VRMS	Temp. Range °C (°F)	M17 Test Freq	Comments
M17/133-00005	17-298-90	AA-5022	SNCCS 0.51 (0.0201)	PTFE 1.68 (0.066)	TC Tube 2.20 (0.0865)	None	NA	0.024 (0.0159)	50 ± 1.5 (69.5)	96.5 (29.4)	1,500	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	Tin-plated M17/133-00004
M17-133-00006	17-298-90	AA-5920	SCCS 0.51 (0.0201)	PTFE 1.68 (0.066)	BC Tube 2.20 (0.0865)	None	NA	0.023 (0.0153)	50 ± 1.5 (69.5)	96.5 (29.4)	1,500	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	
M17-133-00007	17-298-90	AA-5921	SCCS 0.51 (0.0201)	PTFE 1.68 (0.066)	TC Tube 2.20 (0.0865)	None	NA	0.024 (0.0158)	50 ± 1.5 (69.5)	96.5 (29.4)	1,500	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	Tin-plated M17/133-00006
M17/133-00008	17-298-90	AA-5922	SC 0.51 (0.0201)	PTFE 1.68 (0.066)	BC Tube 2.20 (0.0865)	None	NA	0.023 (0.0152)	50 ± 1.5 (69.5)	96.5 (29.4)	1,500	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	
M17/133-00009	17-298-90	AA-5923	SC 0.51 (0.0201)	PTFE 1.68 (0.066)	TC Tube 2.20 (0.0865)	None	NA	0.023 (0.0157)	50 ± 1.5 (69.5)	96.5 (29.4)	1,500	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	Tin-plated M17/133-00008
M17/133-00010	17-298-90	AA-5924	SNCCS 0.51 (0.0201)	PTFE 1.68 (0.066)	BC Tube 2.20 (0.0865)	None	NA	0.023 (0.0154)	50 ± 1.5 (69.5)	96.5 (29.4)	1,500	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	
M17/133-00011	17-298-90	AA-5925	SNCCS 0.51 (0.0202)	PTFE 1.68 (0.066)	TC Tube 2.20 (0.0865)	None	NA	0.024 (0.0159)	50 ± 1.5 (69.5)	96.5 (29.4)	1,500	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	Tin-plated M17/133-00010
M17/133-00012	Non-QPL'd	NA	SCCS 0.51 (0.0201)	PTFE 1.68 (0.066)	Al Tube 2.20 (0.0865)	None	NA	0.011 (0.0075)	50 ± 1.5 (69.5)	98.1 (29.9)	1,500	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	
M17/133-00013	Non-QPL'd	NA	SCCS 0.51 (0.0201)	PTFE 1.68 (0.066)	Tinned Al Tube 2.20 (0.0865)	None	NA	0.012 (0.008)	50 ± 1.5 (69.5)	98.1 (29.9)	1,500	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	Tin-plated M17/133-00012
M17/133-00014	No QPL'd Source	NA	SNCCS 0.51 (0.0201)	PTFE 1.68 (0.066)	Al Tube 2.20 (0.0865)	None	NA	0.011 (0.0075)	50 ± 1.5 (69.5)	98.1 (29.9)	1,500	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	
M17/133-00015	No QPL'd Source	NA	SNCCS 0.51 (0.0201)	PTFE 1.68 (0.066)	Tinned Al Tube 2.20 (0.0865)	None	NA	0.012 (0.008)	50 ± 1.5 (69.5)	98.1 (29.9)	1,500	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	Tin-plated M17/133-00014
M17/133-00016	Non-QLP'd	NA	SCCS 0.51 (0.0201)	PTFE 1.68 (0.066)	SC Tube 2.20 (0.0865)	None	NA	0.024 (0.0158)	50 ± 1.5 (69.5)	98.1 (29.9)	1,500	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	Silver-plated M17/133-00006
M17/133-00017	No QLP'd Source	NA	SNCCS 0.51 (0.0201)	PTFE 1.68 (0.066)	SC Tube 2.20 (0.0865)	None	NA	0.024 (0.0158)	50 ± 1.5 (69.5)	98.1 (29.9)	1,500	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	Silver-plated M17/133-00010
M17/133-00018	No QPL'd Source	NA	SC 0.51 (0.0201)	PTFE 1.68 (0.066)	TC Tube 2.20 (0.0865)	NA	NA	0.023 (0.0157)	50 ± 1.5 (69.5)	98.1 (29.9)	1,500	–40 +125 (–40 +257)	0.5 to 20 GHz, swept	90/10 tin-plated, 300 microinches minimum
M17/134-00001	17-952-85	AA-5411	SC 0.84 (0.033)	PE 2.95 (0.116)	36SC-PE-36SC 5.03 (0.198)	PE-IIIA 6.22 (0.245)	NA	0.067 (0.045)	50 ± 2 (66)	101.1 (30.8)	1,900	–40 +70 (–40 +158)	0.05 to 3 GHz, swept	Water-blocked triax
M17/134-00002	17-952-85	AA-4472	SC 0.84 (0.033)	PE 2.95 (0.116)	36SC-PE-36SC 5.03 (0.198)	PE-IIIA 6.22 (0.245)	NA	0.067 (0.045)	50 ± 2 (66)	101.1 (30.8)	1,900	–40 +70 (–40 +158)	0.05 to 3 GHz, swept	Non-water-blocked M17/134-00001
M17/134-00003	17-952-85	AA-7557	SC 0.84 (0.033)	PE 2.95 (0.116)	36SC-XLPE-36SC 5.03 (0.198)	XLPE 6.22 (0.245)	NA	0.074 (0.050)	50 ± 2 (66)	105.6 (32.2)	1,900	–30 +85 (–22 +185)	0.05 to 3 GHz, swept	Nonhalogen, low-smoke M17/134-00001

M17 Part No.	M17 OPL	TMS Part No.	Conductor mm (inches)	Dielectric mm (inches)	Shields mm (inches)	Jacket mm (inches)	Armor mm (inches)	Weight kg/m (lb/ft)	Impedance ohms Vp (%)	Capacitance pF/m (pF/ft)	Max Oper. Voltage VRMS	Temp. Range °C (°F)	M17 Test Freq	Comments
M17/134-00004	17-952-85	AA-7558	SC 0.84 (0.033)	PE 2.95 (0.116)	36SC-XLPE-36SC 5.03 (0.198)	XLPE 6.22 (0.245)	NA	0.074 (0.050)	50 ± 2 (66)	105.6 (32.2)	1,900	–30 +85 (–22 +185)	0.05 to 3 GHz, swept	Nonhalogen, low-smoke M17/134-00002
M17/135-00001	17-202-88	AA-3833	SC 7/.0296 2.24 (0.0880)	PE 7.24 (0.285)	33SC-PE-33SC 10.11 (0.398)	PUR 12.70 (0.500)	NA	0.238 (0.160)	50 ± 2 (66)	101.1 (30.8)	5,000	–40 +70 (–40 +158)	0.05 to 3 GHz, swept	Water-blocked triax
M17/135-00002	17-202-88	AA-4473	SC 7/.0296 2.24 (0.0880)	PE 7.24 (0.285)	33SC-PE-33SC 10.11 (0.398)	PUR 12.70 (0.500)	NA	0.238 (0.160)	50 ± 2 (66)	101.1 (30.8)	5,000	–40 +70 (–40 +158)	0.05 to 3 GHz, swept	Non-water-blocked M17/135-00001
M17/135-00003	17-202-88	AA-5926	SC 2.06 (0.081)	PE 7.24 (0.285)	33SC-PE-33SC 10.11 (0.398)	PE-IIIA 12.70 (0.500)	NA	0.276 (0.185)	50 ± 2 (66)	101.1 (30.8)	5,000	–40 +70 (–40 +158)	0.05 to 3 GHz, swept	Water-blocked triax
M17/135-00004	17-202-88	AA-5927	SC 2.06 (0.081)	PE 7.24 (0.285)	33SC-PE-33SC 10.11 (0.398)	PE-IIIA 12.70 (0.500)	NA	0.276 (0.185)	50 ± 2 (66)	101.1 (30.8)	5,000	–40 +70 (–40 +158)	0.05 to 3 GHz, swept	Non-water-blocked M17/135-00003
M17/135-00005	17-202-88	AA-7559	SC 2.06 (0.081)	PE 7.24 (0.285)	36SC-XLPE-36SC 5.03 (0.198)	XLPE 12.70 (0.500)	NA	0.276 (0.185)	50 ± 2 (66)	105.0 (32.0)	5,000	–30 +85 (–22 +185)	0.05 to 3 GHz, swept	Water-blocked, nonhalogen, low-smoke M17/135-00003
M17/135-00006	17-202-88	AA-7560	SC 2.06 (0.081)	PE 7.24 (0.285)	36SC-XLPE-36SC 5.03 (0.198)	XLPE 12.70 (0.500)	NA	0.276 (0.185)	50 ± 2 (66)	105.0 (32.0)	5,000	–30 +85 (–22 +185)	0.05 to 3 GHz, swept	Non-water-blocked, nonhalogen, low-smoke M17/135-00004
M17/136-00001	17-809-77	AA-3828	SCCS 7/.004 0.30 (0.0120)	PTFE 1.60 (0.063)	38SC 2.06 (0.081)	PFA-XIII 2.54 (0.100)	NA	0.018 (0.012)	75 ± 3 (69.5)	64.0 (19.5)	1,200	–55 +230 (–67 +446)	3 GHz, unswept	High-temperature M17/94-RG179
M17/137-00001	17-810-77	AA-3829	SCCS 7/.004 0.30 (0.0120)	PTFE 2.59 (0.102)	38SC 3.05 (0.120)	PFA-XIII 3.58 (0.141)	NA	0.030 (0.020)	95 ± 5 (69.5)	50.5 (15.4)	1,500	–55 +230 (–67 +446)	3 GHz, unswept	High-temperature M17/95-RG180
M17/138-00001	17-812-77	AA-3830	SCCS 7/.0067 0.51 (0.0201)	PTFE 1.52 (0.060)	38SC 1.98 (0.078)	PFA-XIII 2.49 (0.098)	NA	0.018 (0.0122)	50 ± 1.5 (69.5)	96.5 (29.4)	1,500	–55 +230 (–67 +446)	0.50 to 3 GHz, swept	High-temperature M17/113-RG316
M17/139-00001	17-359-84	AA-3831	SCBeCu 7/.004 0.30 (0.0120)	PTFE 2.59 (0.102)	38SC CadBr 3.05 (0.120)	PFA-XIII 3.58 (0.141)	NA	0.029 (0.0194)	95 ± 5 (69.5)	50.5 (15.4)	1,500	–55 +230 (–67 +446)	3 GHz, unswept	High-strength M17/95-RG180
M17/151-00001	17-543-90	AA-5023	SCCS 0.29 (0.0113)	PTFE 0.94 (0.037)	BC Tube 1.19 (0.047)	None	NA	0.0067 (0.0045)	50 ± 2.5 (69.5)	96.5 (29.4)	1,000	–40 +100 (–40 +212)	0.50 to 20 GHz, swept	0.047" semirigid
M17/151-00002	17-543-90	AA-5024	SCCS 0.29 (0.0113)	PTFE 0.94 (0.037)	TC Tube 1.19 (0.047)	None	NA	0.007 (0.0048)	50 ± 2.5 (69.5)	96.5 (29.4)	1,000	–40 +100 (–40 +212)	0.50 to 20 GHz, swept	Tin-plated M17/151-00001
M17/152-00001	17-290-89	AA-4920	SCCS 7/.0067 0.51 (0.0201)	PTFE 1.52 (0.060)	38SC:38SC 2.44 (0.096)	FEP-IX 2.90 (0.114)	NA	0.028 (0.0185)	50 ± 2 (69.5)	96.5 (29.4)	1,200	–55 +200 (–67 +392)	0.05 to 12.4 GHz, swept	Double-shielded M17/113-RG316
M17/153-00001	No QPL'd Source	NA	SCCS 7/.0063 0.48 (0.0189)	PE 1.52 (0.060)	38SC:38SC 2.44 (0.096)	PVC-IIA 2.90 (0.114)	NA	0.045 (0.0300)	50 ± 2 (66)	101.1 (30.8)	1,500	–40 +85 (–40 +185)	0.05 to 12.4 GHz, swept	Canceled. Use M17/152-00001
M17/154-00001	17-544-90	AA-5025	SCCS 0.20 (0.0080)	PTFE 0.66 (0.026)	BC Tube 0.86 (0.034)	None	NA	0.0031 (0.0026)	50 ± 3 (69.5)	96.5 (29.4)	750	–40 +100 (–40 +212)	0.50 to 20 GHz, swept	0.034" semirigid

M17 Part No.	M17 OPL	TMS Part No.	Conductor mm (inches)	Dielectric mm (inches)	Shields mm (inches)	Jacket mm (inches)	Armor mm (inches)	Weight kg/m (lb/ft)	Impedance ohms Vp (%)	Capacitance pF/m (pF/ft)	Max Oper. Voltage VRMS	Temp. Range °C (°F)	M17 Test Freq	Comments
M17/154-00002	17-544-90	AA-5026	SCCS 0.20 (0.008)	PTFE 0.66 (0.026)	TC Tube 0.86 (0.034)	None	NA	0.0042 (0.0028)	50 ± 2 (66)	96.5 (29.4)	750	–40 +100 (–40 +212)	0.50 to 20 GHz, swept	Tin-plated M17/154-00001
M17/155-00001	17-304-83	AA-4636	TC19/.0072 0.90 (0.0355)	PE 2.95 (0.116)	36TC 3.53 (0.139)	PVC-IIA 4.95 (0.195)	NA	0.039 (0.0260)	50 ± 2 (66)	101.1 (30.8)	1,900	–40 +85 (–40 +185)	400 MHz, unswept	Use M17/197-00001 LS/LT jacket
M17/156-00001	17-749-85	AA-5606	BC 2.59 (0.1019)	PTFE 8.43 (0.332)	32BC:32BC 10.01 (0.394)	FG Braid-V 11.81 (0.465)	NA	0.357 (0.2400)	50 ± 2 (69.5)	96.5 (29.4)	6,000	–55 +200 (–67 +392)	400 MHz, unswept	Unswept M17/52-RG119
M17/157-00001	17-305-83	AA-4638	TC 27/.005 0.78 (0.0308)	PE 2.44 (0.096)	36TC 3.02 (0.1190)	PVC-IIA 4.06 (0.160)	NA	0.031 (0.0210)	50 ± 2 (66)	101.1 (30.8)	1,900	–40 +85 (–40 +185)	400 MHz, unswept	Use M17/198-00001 LS/LT jacket
M17/158-00001	17-664-83	AA-4639	SCCS 0.94 (0.0370)	PE 2.95 (0.116)	36SC:36SC 4.11 (0.162)	FEP-IX 4.95 (0.195)	NA	0.083 (0.0560)	50 ± 2 (69.5)	96.5 (29.4)	1,900	–55 +200 (–67 +392)	400 MHz, unswept	Unswept M17/60-RG142
M17/159-00001	17-598-81	AA-4640	SC 7/.0315 2.39 (0.0940)	PTFE 7.24 (0.285)	34SC 7.98 (0.3140)	FG Braid-V 10.41 (0.410)	NA	0.325 (0.2180)	50 ± 2 (69.5)	96.5 (29.4)	2,500	–55 +250 (–67 +482)	400 MHz, unswept	Unswept M17/65-RG165
M17/160-00001	17-1102-85	AA-4641	BC 4.95 (0.1950)	PE 17.27 (0.680)	34SC:34SC 18.75 (0.738)	PVC-IIA 22.73 (0.895)	NA	0.775 (0.520)	50 ± 2 (66)	101.1 (30.8)	11,000	–40 +85 (–40 +185)	400 MHz, unswept	Use M17/212-00001 LS/LT jacket
M17/161-00001	No QPL'd Source	NA	BC 4.88 (0.192)	PTFE 15.75 (0.620)	32BC 16.69 (0.657)	FG Braid-V 18.54 (0.730)	NA	0.968 (0.6500)	50 ± 2 (69.5)	96.5 (29.4)	7,000	–55 +250 (–67 +482)	400 MHz, unswept	Unswept M17/72-RG211
M17/161-00002	No QPL'd Source	NA	BC 4.88 (0.192)	PTFE 15.75 (0.620)	32BC 16.69 (0.657)	FG Braid-V 18.54 (0.730)	Al Braid 20.19 (0.795)	0.968 (0.650)	50 ± 2 (69.5)	96.5 (29.4)	7,000	–55 +250 (–67 +482)	400 MHz, unswept	Armored M17/161-00001
M17/162-00001	17-1104-85	AA-4653	SC 1.41 (0.0556)	PE 4.70 (0.185)	34SC:34SC 6.17 (0.243)	PVC-IIA 8.43 (0.332)	NA	0.133 (0.0890)	50 ± 2 (66)	101.1 (30.8)	3,000	–40 +85 (–40 +185)	400 MHz, unswept	Use M17/199-00001 LS/LT jacket
M17/163-00001	17-804-77	AA-4643	BC 7/.0296 2.26 (0.0888)	PE 7.24 (0.285)	33BC 8.08 (0.318)	PVC-IIA 10.29 (0.405)	NA	0.165 (0.1110)	50 ± 2 (66)	101.1 (30.8)	5,000	–40 +85 (–40 +185)	400 MHz, unswept z	Unswept M17/74-RG213
M17/164-00001	17-804-77	AA-4645	SC 7/.0296 2.26 (0.0888)	PE 7.24 (0.285)	34SC:34SC 10.11 (0.398)	PVC-IIA 10.80 (0.425)	NA	0.209 (0.140)	50 ± 2 (66)	101.1 (30.8)	5,000	–40 +85 (–40 +185)	400 MHz, unswept	Use M17/214-00001 LS/LT jacket
M17/164-00002	17-984-85	AA-4646	SC 7/.0296 2.26 (0.0888)	PE 7.24 (0.285)	34SC:34SC 10.11 (0.398)	TPE 10.80 (0.425)	NA	0.209 (0.140)	50 ± 2 (66)	101.1 (30.8)	5,000	–55 +85 (–67 +185)	400 MHz, unswept	Unswept M17/75-RG365
M17/165-00001	17-1102-85	AA-4647	BC 2.69 (0.106)	PE 9.40 (0.370)	33BC:33BC 11.07 (0.436)	PVC-IIA 13.84 (0.545)	NA	0.335 (0.225)	50 ± 2 (66)	101.1 (30.8)	7,000	–40 +85 (–40 +185)	400 MHz, unswept	Use M17/215-00001 LS/LT Jacket
M17/165-00002	17-1102-85	AA-6544	BC 2.69 (0.106)	PE 9.40 (0.370)	33BC:33BC 11.07 (0.436)	PVC-IIA 13.84 (0.545)	Al Braid 15.62 (0.615)	0.462 (0.310)	50 ± 2 (66)	101.1 (30.8)	7,000	–40 +85 (–40 +185)	400 MHz, unswept	Armored M17/215-00001
M17/166-00001	17-1102-85	AA-4648	BC 4.95 (0.195)	PE 17.27 (0.680)	30BC 18.44 (0.726)	PVC-IIA 22.10 (0.870)	NA	0.760 (0.510)	50 ± 2 (66)	101.1 (30.8)	11,000	–40 +85 (–40 +185)	400 MHz, unswept	Use M17/216-00001 LS/LT jacket
M17/167-00001	17-303-83	AA-4649	SC 0.89 (0.035)	PE 2.95 (0.116)	36SC:36SC 4.11 (0.162)	PVC-IIA 5.38 (0.212)	NA	0.061 (0.041)	50 ± 2 (66)	101.1 (30.8)	1,900	–40 +85 (–40 +185)	400 MHz, unswept	Unswept M17/84-RG223; Use M17/200-00001 LS/LT jacket

M17 Part No.	M17 OPL	TMS Part No.	Conductor mm (inches)	Dielectric mm (inches)	Shields mm (inches)	Jacket mm (inches)	Armor mm (inches)	Weight kg/m (lb/ft)	Impedance ohms Vp (%)	Capacitance pF/m (pF/ft)	Max Oper. Voltage VRMS	Temp. Range °C (°F)	M17 Test Freq	Comments
M17/168-00001	17-598-81	AA-4650	SC 7/.028 2.13 (0.084)	Taped PTFE 6.48 (0.255)	34SC:34SC 7.95 (0.313)	FG Braid-V 10.54 (0.415)	NA	0.276 (0.185)	50 ± 2 (71)	95.1 (29.0)	5,000	–55 +200 (–67 +392)	400 MHz, unswept	Unswept M17/92-RG115
M17/168-00002	17-598-81	AA-6306	SC 7/.028 2.13 (0.084)	Taped PTFE 6.48 (0.255)	34SC:34SC 7.95 (0.313)	FEP-IX 8.74 (0.344)	NA	0.276 (0.185)	50 ± 2 (71)	95.1 (29.0)	5,000	–55 +200 (–67 +392)	400 MHz, unswept	FEP-jacketed, unswept M17/92-RG115
M17/169-00001	17-666-84	AA-4651	SCCS 7/.004 0.30 (0.012)	PTFE 0.84 (0.033)	38SC 1.30 (0.051)	FEP-IX 1.80 (0.071)	NA	0.009 (0.006)	50 ± 2 (69.5)	96.5 (29.4)	1,000	–55 +200 (–67 +392)	400 MHz, unswept	Unswept M17/93-RG178
M17/170-00001	17-811-77	AA-4652	SCCS 0.94 (0.037)	PE 2.95 (0.116)	36SC 3.53 (0.139)	FEP-IX 4.32 (0.170)	NA	0.058 (0.039)	50 ± 2 (69.5)	96.5 (29.4)	1,900	–55 +200 (–67 +392)	400 MHz, unswept	Unswept M17/111-RG303
M17/171-00001	17-474-86	AA-4653	SCCS 1.50 (0.0590)	PTFE 4.70 (0.185)	34SC:34SC 6.17 (0.243)	FEP-IX 7.11 (0.28)	NA	0.138 (0.092)	50 ± 2 (69.5)	96.5 (29.4)	3,000	–55 +200 (–67 +392)	400 MHz, unswept	Unswept M17/112-RG304
M17/172-00001	17-812-77	AA-4654	SCCS 7/.0067 0.51 (0.0201)	PTFE 1.52 (0.060)	38SC 1.98 (0.078)	FEP-IX 2.49 (0.098)	NA	0.017 (0.012)	50 ± 2 (69.5)	96.5 (29.4)	1,200	–55 +200 (–67 +392)	400 MHz, unswept	Unswept M17/113-RG316
M17/173-00001	17-813-77	AA-4655	CCS 7/.0063 0.48 (0.0189)	PE 1.52 (0.060)	38TC 1.98 (0.078)	PVC-IIA 2.79 (0.110)	NA	0.014 (0.0095)	50 ± 2 (66)	101.1 (30.8)	1,500	–40 +85 (–40 +185)	400 MHz, unswept	Use M17/217-00001 LS/LT jacket
M17/174-00001	17-429-84	AA-4656	SC 7/.0312 2.39 (0.094)	PTFE 7.24 (0.285)	34SC:34SC 8.71 (0.343)	FEP-IX 9.91 (0.390)	NA	0.261 (0.175)	50 ± 2 (69.5)	96.5 (29.4)	2,500	–55 +200 (–67 +392)	400 MHz, unswept	Unswep M17/127-RG393t
M17/175-00001	17-671-83	AA-4657	SC 19/.008 0.98 (0.0384)	PE 2.95 (0.116)	36SC:36SC 4.11 (0.162)	FEP-IX 4.95 (0.195)	NA	0.074 (0.050)	50 ± 2 (69.5)	96.5 (29.4)	1,900	–55 +200 (–67 +392)	400 MHz, unswept	Unswept M17/128-RG400
M17/176-00002	Non- QLP'd	AA-51272	C:SPA 19/.005 0.60 (0.0235)	PTFE 1.07 (0.042)	38SCBeCu 2.59 (0.102)	PFA-XIII 3.28 (0.129)	NA	0.027 (0.018)	77 ± 3 (71)	78.7 (24.0)	1,000	–55 +200 (–67 +392)	10 MHz, unswept	Use up to 10 MHz
M17/176-00003	No QPL'd Source	NA	2C:SPA 19/005 0.60 (0.0235)	ETFE 1.07 (0.042)	38SCBeCu 2.59 (0.102)	P FA, FEP, ETFE, ETCFE 3.18 (0.125)	NA	0.024 (0.016)	77 ± 3 (78)	78.7 (24.0)	1,000	–55 +150 (–67 +302)	10 MHz, unswept	Use up to 10 MHz
M17/177-00001	17-246-90	AA-6513	SCCS 7/.004 0.30 (0.012)	PTFE 2.59 (0.102)	38SC-FEP-38SC 4.04 (0.159)	FEP-IX 4.67 (0.184)	NA	0.051 (0.034)	95 ± 3 (69.5)	50.5 (15.4)	1,500	–55 +200 (–67 +392)	3 GHz, unswept	Use up to 3,000 MHz
M17/178-00001	No QPL'd Source	NA	SCCS 7/.004 0.30 (0.012)	PTFE 2.59 (0.102)	38SC:34NC Composite 4.32 (0.170)	Polyester Braid 6.86 (0.270)	NA	0.089 (0.060)	95 ± 5 (69.5)	50.5 (15.4)	1,500	–55 +150 (–67 +302)	3 GHz, unswept	Use up to 3,000 MHz
M17/179-00001	No QPL'd Source	NA	SCCS 7/.004 0.30 (0.012)	PTFE 1.60 (0.063)	38SC:34NC Composite 3.12 (0.123)	Polyester Braid 4.95 (0.195)	NA	0.054 (0.036)	75 ± 3 (69.5)	64.0 (19.5)	1,200	–55 +150 (–67 +302)	3 GHz, unswept	Use up to 3,000 MHz
M17/180-00001	17-05-92	AA-7276	CCS 0.72 (0.0285)	PE 4.70 (0.185)	4SC-34BC 6.17 (0.243)	XLPE 8.43 (0.332)	NA	0.137 (0.092)	75 ± 3 (66)	67.6 (20.6)	2,700	–30 +80 (–22 +176)	3 GHz, unswept	Nonhalogen, low-smoke M17/2-RG6
M17/181-00001	17-05-92	AA-7277	TC 7/.0159 1.21 (0.0477)	PE 7.24 (0.285)	33BC 8.08 (0.318)	XLPE 10.29 (0.405)	NA	0.161 (0.108)	75 ± 3 (66)	67.6 (20.6)	5,000	–30 +80 (–22 +176)	1 GHz, unswept	Nonhalogen, low-smoke M17/6-RG11

M17 Part No.	M17 OPL	TMS Part No.	Conductor mm (inches)	Dielectric mm (inches)	Shields mm (inches)	Jacket mm (inches)	Armor mm (inches)	Weight kg/m (lb/ft)	Impedance ohms Vp (%)	Capacitance pF/m (pF/ft)	Max Oper. Voltage VRMS	Temp. Range °C (°F)	M17 Test Freq	Comments
M17/181-00002	17-05-92	AA-7278	TC 7/.0159 1.21 (0.0477)	PE 7.24 (0.285)	34BC 8.08 (0.318)	XLPE 10.29 (0.405)	Al Braid 12.07 0.475 ()	0.197 (0.132)	75 ± 3 (66)	67.6 (20.6)	5,000	–30 +80 (–22 +176)	1 GHz, unswept	Armored M17/181-00001
M17/182-00001	17-05-92	AA-7279	2C:BC 7/.0152 1.16 (0.0456)	PE 7.24 (0.285)	34TC:34TC 8.71 (0.343)	XLPE 10.29 (0.405)	NA	0.212 (0.142)	95 ± 5 (66)	53.5 (16.3)	1,000	–30 +80 (–22 +176)	200 MHz, unswept	Nonhalogen, low-smoke M17/15-RG22
M17/182-00002	17-05-92	AA-7280	2C:BC 7/.0152 1.16 (0.0456)	PE 7.24 (0.285)	34TC:34TC 8.71 (0.343)	XLPE 10.67 (0.420)	Al Braid 12.45 (0.490)	0.252 (0.169)	95 ± 5 (66)	53.5 (16.3)	1,000	–30 +80 (–22 +176)	200 MHz, unswept	Armored M17/182-00001
M17/183-00001	17-05-92	AA-7281	TC 19/.0072 0.90 (0.0355)	PE 2.95 (0.116)	36TC 3.53 (0.139)	XLPE 4.95 (0.195)	NA	0.045 (0.030)	50 ± 2 (66)	101.1 (30.8)	1,900	–30 +80 (–22 +176)	0.05 to 1 GHz, swept	Nonhalogen, low-smoke M17/28-RG58
M17/184-00001	17-05-92	AA-7282	CCS 0.57 (0.0226)	PE 3.71 (0.146)	34BC 4.45 (0.175)	XLPE 6.15 (0.242)	NA	0.064 (0.043)	75 ± 3 (66)	67.6 (20.6)	2,300	–30 +80 (–22 +176)	1 GHz, unswept	Nonhalogen, low-smoke M17/29-RG59
M17/185-00001	17-05-92	AA-7283	CCS 0.64 (0.0253)	Airspaced PE 3.71 (0.146)	34BC 4.45 (0.175)	XLPE 6.15 (0.242)	NA	0.042 (0.063)	93 ± 5 (81)	44.3 (13.5)	750	–30 +80 (–22 +176)	1 GHz, unswept	Nonhalogen, low-smoke M17/30-RG62
M17/186-00001	17-05-92	AA-7284	2C:TC 7/.0126 0.96 (0.0378)	PE (each) 2.01 (0.079)	36TC 4.60 (0.181)	XLPE 5.97 (0.235)	NA	0.061 (0.041)	75 ± 3 (68)	64.3 (19.6)	1,000	–30 +80 (–22 +176)	10 MHz, unswept	Nonhalogen, low-smoke M17/45-RG108
M17/187-00001	17-05-92	AA-7285	TC 27/.005 0.78 (0.0308)	PE 2.44 (0.096)	36TC 3.02 (0.119)	XLPE 4.06 (0.160)	NA	0.034 (0.023)	50 ± 2 (66)	101.1 (30.8)	1,900	–30 +80 (–22 +176)	0.05 to 1 GHz, swept	Nonhalogen, low-smoke M17/54-RG122
M17/188-00001	17-05-92	AA-7286	SC 1.41 (0.0556)	PE 2.44 (0.185)	34SC:34SC 6.17 (0.243)	XLPE 8.43 (0.332)	NA	0.147 (0.099)	50 ± 2 (66)	101.1 (30.8)	3,000	–30 +80 (–22 +176)	0.05 to 11 GHz, swept	Nonhalogen, low-smoke M17/73-RG212
M17/189-00001	17-05-92	AA-7287	BC 7/.0296 2.26 (0.0888)	PE 7.24 (0.285)	33BC 8.08 (0.318)	XLPE 10.29 (0.405)	NA	0.180 (0.121)	50 +/-2 (66)	101.1 (30.8)	5,000	–30 +80 (–22 +176)	0.05 to 1 GHz, swept	Nonhalogen, low-smoke M17/74-RG213
M17/189-00002	17-05-92	AA-7288	BC 7/.0296 2.26 (0.0888)	PE 7.24 (0.285)	33BC 8.08 (0.318)	XLPE 10.29 (0.405)	Al Braid 12.07 (0.475)	0.217 (0.146)	50 ± 2 (66)	101.1 (30.8)	5,000	–30 +80 (–22 +176)	0.05 to 1 GHz, swept	Armored M17/189-00001
M17/190-00001	17-05-92	AA-7289	SC 7/.0296 2.26 (0.0888)	PE 7.24 (0.285)	34SC:34SC 8.71 (0.343)	XLPE 10.80 (0.425)	NA	0.229 (0.154)	50 ± 2 (66)	101.1 (30.8)	5,000	–30 +80 (–22 +176)	0.05 to 11 GHz, swept	Nonhalogen, low-smoke M17/75-RG214
M17/191-00001	17-05-92	AA-7290	TC 7/.0159 1.21 (0.0477)	PE 7.24 (0.285)	34BC:34BC 8.71 (0.343)	XLPE 10.80 (0.425)	NA	0.207 (0.139)	75 ± 3 (66)	67.6 (20.6)	5,000	–30 +80 (–22 +176)	3 GHz, unswept	Nonhalogen, low-smoke M17/77-RG216
M17/192-00001	17-05-92	AA-7291	BC 2.69 (0.106)	PE 9.40 (0.370)	33BC:33BC 11.07 (0.436)	XLPE 13.84 (0.545)	NA	0.369 (0.248)	50 ± 2 (66)	101.1 (30.8)	7,000	–30 +80 (–22 +176)	0.05 to 3 GHz, swept	Nonhalogen, low-smoke M17/78-RG217
M17/192-00002	17-95-94	AA-8111	BC 2.69 (0.106)	PE 9.40 (0.370)	33BC:33BC 11.07 (0.436)	XLPE 13.84 (0.545)	NA	0.369 (0.248)	50 ± 2 (66)	101.1 (30.8)	7,000	–30 +80 (–22 +176)	0.05 to 3 GHz, swept	M17/192-00001, with temperature cycling
M17/193-00001	17-05-92	AA-7292	BC 4.95 (0.195)	PE 17.27 (0.680)	30BC 18.44 (0.726)	XLPE 22.10 (0.870)	NA	0.776 (0.521)	50 ± 2 (66)	101.1 (30.8)	11,000	–30 +80 (–22 +176)	0.05 to 1 GHz	Nonhalogen, low-smoke M17/79-RG218
M17/193-00002	17-05-92	AA-7293	BC 4.95 (0.195)	PE 17.27 (0.680)	30BC 18.44 (0.726)	XLPE 22.10 (0.870)	Al Braid 24.00 (0.945)	0.851 (0.571)	50 ± 2 (66)	101.1 (30.8)	11,000	–30 +80 (–22 +176)	0.05 to 1 GHz, swept	Armored M17/193-00001

M17 Part No.	M17 OPL	TMS Part No.	Conductor mm (inches)	Dielectric mm (inches)	Shields mm (inches)	Jacket mm (inches)	Armor mm (inches)	Weight kg/m (lb/ft)	Impedance ohms Vp (%)	Capacitance pF/m (pF/ft)	Max Oper. Voltage VRMS	Temp. Range °C (°F)	M17 Test Freq	Comments
M17/194-00001	17-05-92	AA-7294	SC 0.89 (0.0350)	PE 2.95 (0.116)	36SC:36SC 4.11 (0.160)	XLPE 5.38 (0.212)	NA	0.066 (0.044)	50 ± 2 (66)	101.1 (30.8)	1,900	–30 +80 (–22 +176)	0.04 to 12.4 GHz, swept	Nonhalogen, low-smoke M17/84-RG223
M17/195-00001	17-05-92	AA-7295	CCS 0.64 (0.0253)	Airspaced PE 3.71 (0.146)	34BC:34TC 5.03 (0.198)	XLPE 2.79 (0.245)	NA	0.079 (0.053)	93 ± 5 (85)	44.3 (13.5)	750	–30 +80 (–22 +176)	1 GHz, unswept	Nonhalogen, low-smoke M17/90-RG71
M17/196-00001	17-05-92	AA7296	CCS 7/.0063 0.48 (0.0189)	PE 1.52 (0.060)	38TC 1.98 (0.078)	XLPE 2.79 (0.110)	NA	0.013 (0.009)	50 ± 2 (66)	101.1 (30.8)	1,500	–30 +80 (–22 +176)	0.05 to 1 GHz, swept	Nonhalogen, low-smoke M17/119-RG174
M17/197-00001	17-05-92	AA-7297	TC 19/.0072 0.90 (0.0355)	PE 2.95 (0.116)	36TC 3.53 (0.139)	XLPE 4.95 (0.195)	NA	0.046 (0.0310)	50 +/-2 (66)	101.1 (30.8)	1,500	–30 +80 (–22 +176)	400 MHz, unswept	Nonhalogen, low-smoke M17/155-00001
M17/198-00001	17-05-92	AA-7298	TC 27/.005 0.78 (0.0308)	PE 2.44 (0.096)	36TC 3.02 (0.119)	XLPE 4.06 (0.160)	NA	0.036 (0.024)	50 ± 2 (66)	101.1 (30.8)	1,900	–30 +80 (–22 +176)	400 MHz, unswept	Nonhalogen, low-smoke M17/157-00001
M17/199-00001	17-05-92	AA-7299	SC 1.41 (0.0556)	PE 4.70 (0.185)	34SC:34SC 6.17 (0.243)	XLPE 8.43 (0.332)	NA	0.149 (0.100)	50 ± 2 (66)	101.1 (30.8)	3,000	–30 +80 (–22 +176)	400 MHz, unswept	Nonhalogen, low-smoke M17/162-00001
M17/200-00001	17-05-92	AA-7300	SC 0.89 (0.0350)	PE 2.95 (0.116)	36SC:36SC 4.11 (0.162)	XLPE 5.38 (0.212)	NA	0.066 (0.044)	50 ± 2 (66)	101.1 (30.8)	1,900	–30 +80 (–22 +176)	400 MHz, unswept	Nonhalogen, low-smoke M17/167-00001
M17/201-00001	No QPL'd Source	NA	2C:SPA 19/.005 0.63 (0.0248)	XLETFE 1.32 (0.052)	38TC 1.78 (0.070)	XLETFE 3.48 (0.137)	NA	0.021 (0.0142)	77 ± 5 (66)	98.4 (30.0)	600	–65 +150 (–85 +302)	1 MHz, unswept	Single-shield data bus cable
M17/201-00002	No QPL'd Source	NA	2C:SPA 19/.0063 0.79 (0.0312)	XLETFE 1.63 (0.064)	38TC 2.21 (0.087)	XLETFE 4.19 (0.165)	NA	0.033 (0.0219)	77 ± 5 (66)	98.4 (30.0)	600	–65 +150 (–85 +302)	1 MHz, unswept	Single-shield data bus cable
M17/201-00003	No QPL'd Source	NA	2C:SPA 19/.005 0.0248 (0.63)	XLETFE 0.048 (1.22)	38TC 1.68 (0.066)	XLETFE 3.30 (0.130)	NA	0.024 (0.0159)	77 ± 5 (66)	98.4 (30.0)	600	–65 +150 (–85 +302)	1 MHz, unswept	Single-shield data bus cable
M17/202-00001	No QPL'd Source	NA	2C:SPA 19/.005 0.63 (0.0248)	XLETFE 0.048 (1.22)	38TC:38TC 2.13 (0.084)	XLETFE 3.73 (0.147)	NA	0.039 (0.0262)	77 ± 5 (66)	98.4 (30.0)	600	–65 +150 (–85 +302)	1 MHz, unswept	Single-shield data bus cable
M17/203-00001	No QPL'd Source	NA	2C:SPA 19/.005 0.63 (0.0248)	XLETFE 0.048 (1.22)	38TC:38TC Mu Metal Interlayer 3.56 (0.140)	XLETFE 4.09 (0.161)	NA	0.043 (0.0291)	77 ± 5 (66)	98.4 (30.0)	600	–65 +150 (–85 +302)	1 MHz, unswept	Single-shield data bus cable
M17/204-00001	Assigned but not used	NA					NA							
M17/205-00018	No QPL'd Source	NA	SC 0.76 (0.0298)	LDTFE 2.11 (0.083)	Helical SPC Tape 38SC: 2.77 (0.109)	PFA-XIII 3.05 (0.120)	NA	0.022 (0.015)	50 ± 2 (82)	88.6 (27.0)	1,900	–55 +200 (–67 +392)	0.05 to 18 GHz, swept	Consider TFlex 405 or TFlex 402
M17/205-00050	No QPL'd Source	NA	SC 0.76 (0.0298)	LDTFE Tape 2.11 (0.083)	Helical SPC Tape 38SC: 2.77 (0.109)	PFA-XIII 3.05 (0.120)	NA	0.022 (0.015)	50 ± 2 (82)	88.6 (27.0)	1,900	–55 +200 (–67 +392)	0.05 to 50 GHz, swept	Consider TFlex 405 or TFlex 402

M17 Part No.	M17 OPL	TMS Part No.	Conductor mm (inches)	Dielectric mm (inches)	Shields mm (inches)	Jacket mm (inches)	Armor mm (inches)	Weight kg/m (lb/ft)	Impedance ohms Vp (%)	Capacitance pF/m (pF/ft)	Max Oper. Voltage VRMS	Temp. Range °C (°F)	M17 Test Freq	Comments
M17/206-00018	No QPL'd Source	NA	SC 0.93 (0.0365)	PTFE 2.97 (0.117)	SC Strip-Al Kptn 38SC: 3.91 (0.154)	FEP-IX 4.29 (0.169)	NA	0.060 (0.040)	50 ± 2 (69.5)	105.0 (32.0)	1,900	–55 +200 (–67 +392)	0.05 to 18 GHz, swept	Consider SF-142
M17/206-00030	No QPL'd Source	NA	SC 0.93 (0.0365)	PTFE 2.97 (0.117)	SC Strip-Al Kptn 38SC: 3.91 (0.154)	FEP-IX 4.29 (0.169)	NA	0.060 (0.040)	50 ± 2 (69.5)	105.0 (32.0)	1,900	–55 +200 (–67 +392)	0.05 to 30 GHz, swept	Consider SF-142
M17/207-00001	Assigned but not used	NA												
M17/208-00001	No QPL'd Source	NA	BCCS 0.18 (0.007)	Airspaced PE 7.24 (0.285)	34BC 7.98 (0.314)	XLPE 10.29 (0.405)	NA	0.133 (0.089)	185 ± 10 (83)	23.6 (7.2)	1,000	–40 +80 (–40 +176)	1 GHz, unswept	Nonhalogen, low-smoke M17/47-RG114
M17/209-00001	No QPL'd Source	NA	BCCS 2.68 (0.1054)	PE 17.27 (0.680)	30BC 18.44 (0.726)	XLPE 22.10 (0.670)	NA	0.752 (0.505)	75 ± 3 (66)	72.2 (22.0)	10,000	–40 +80 (–40 +176)	1 GHz, unswept	Nonhalogen, low-smoke M17/64-RG164
M17/210-00001	17-05-92	AA-3404	BC 4.95 (0.195)	PE 17.27 (0.680)	34SC:34SC 18.75 (0.738)	XLPE 22.73 (0.895)	NA	0.852 (0.572)	50 ± 2 (66)	105.6 (32.2)	11,000	–40 +80 (–40 +176)	1 GHz, unswept	Nonhalogen, low-smoke M17/67-RG177
M17/211-00001	17-05-92	AA-8063	TC 7/.0159 1.21 (0.0477)	CPE & PE 7.49 (0.295)	34TC 8.23 (0.324)	XLPE 10.29 (0.405)	NA	0.164 (0.110)	72 ± 3 (63)	78.7 (24.0)	5,000	–40 +80 (–40 +176)	1 GHz, unswept	Nonhalogen, low-smoke M17/126-RG391
M17/211-00002	17-05-92	AA-8064	BC 7/.0159 1.21 (0.0477)	CPE & PE 7.49 (0.295)	34TC 8.23 (0.324)	XLPE 10.29 (0.405)	Al Braid 12.07 (0.475)	0.201 (0.135)	72 ± 3 (63)	78.7 (24.0)	5,000	–40 +80 (–40 +176)	1 GHz, unswept	Armored M17/211-00001
M17/212-00001	17-05-92	AA-8065	BC 4.95 (0.195)	PE 17.27 (0.680)	34SC:34SC 18.75 (0.738)	XLPE 22.73 (0.895)	NA	0.852 (0.572)	50 ± 2 (66)	105.6 (32.2)	11,000	–40 +80 (–40 +176)	400 MHz, unswept	Nonhalogen, low-smoke M17/160-00001
M17/213-00001	17-05-92	AA-8066	BC 7/.0296 2.26 (0.0888)	PE 7.24 (0.285)	33BC 8.08 (0.318)	XLPE 10.29 (0.405)	NA	0.180 (0.121)	50 ± 2 (66)	105.6 (32.2)	5,000	–40 +80 (–40 +176)	400 MHz, unswept	Nonhalogen, low-smoke M17/163-00001
M17/214-00001	17-05-92	AA-8067	SC 7/.0296 2.26 (0.888)	PE 7.24 (0.285)	34SC:34SC 8.71 (0.343)	XLPE 10.80 (0.425)	NA	0.229 (0.154)	50 ± 2 (66)	105.6 (32.2)	7,000	–40 +80 (–40 +176)	400 MHz, unswept	Nonhalogen, low-smoke M17/164-00001
M17/215-00001	17-05-92	AA-8068	BC 2.69 (0.1060)	PE 9.40 (0.370)	33BC:33BC 10.24 (0.403)	XLPE 13.84 (0.545)	NA	(0.369 0.248)	50 ± 2 (66)	105.6 (32.2)	7,000	–40 +80 (–40 +176)	400 MHz, unswept	Nonhalogen, low-smoke M17/165-00001
M17/216-00001	17-05-92	AA-8069	BC 4.95 (0.195)	PE 17.27 (0.680)	30BC 18.44 (0.726)	XLPE 22.10 (0.870)	NA	0.776 (0.521)	50 ± 2 (66)	105.6 (32.2)	11,000	–40 +80 (–40 +176)	400 MHz, unswept	Nonhalogen, low-smoke M17/166-00001
M17/217-00001	17-05-92	AA-8070	BCCS 7/.0063 0.48 (0.0189)	PE 1.52 (0.060)	38TC 1.98 (0.078)	XLPE 2.79 (0.110)	NA	0.015 (0.010)	50 ± 2 (66)	105.6 (32.2)	1,500	–40 +80 (–40 +176)	400 MHz, unswept	Nonhalogen, low-smoke M17/173-00001
M17/218-00001	17-05-92	AA-8071	BCCS 0.64 (0.0253)	Airspaced PE 7.24 (0.285)	33BC 8.08 (0.318)	XLPE 10.29 (0.405)	NA	0.142 (0.095)	125 ± 6 (86)	36.1 (11.0)	750	–40 +80 (–40 +176)	1 GHz, unswept	Non halogen, low-smoke M17/31-RG63
M17/218-00002	17-05-92	AA-8072	BCCS 0.64 (0.0253)	Airspaced PE 7.24 (0.285)	33BC 8.08 (0.318)	XLPE 10.29 (0.405)	Al Braid 12.07 (0.475)	0.206 (0.138)	125 ± 6 (86)	36.1 (11.0)	750	–40 +80 (–40 +176)	1 GHz, unswept	Armored M17/218-00001

M17 Part No.	M17 OPL	TMS Part No.	Conductor mm (inches)	Dielectric mm (inches)	Shields mm (inches)	Jacket mm (inches)	Armor mm (inches)	Weight kg/m (lb/ft)	Impedance ohms Vp (%)	Capacitance pF/m (pF/ft)	Max Oper. Voltage VRMS	Temp. Range °C (°F)	M17 Test Freq	Comments
M17/219-00001	Proposed Spec	NA	SCCS 0.59 (0.0232)	PTFE 1.93 (0.076)	BC Tube 2.44 (0.096)	None	NA	0.022 (0.015)	50 ± 1 (59.5)	105.0 (32.0)	1,700	–40 +125 (–40 +257)	0.50 to 50 GHz, swept	Proposed Spec
M17/220-00001	17-041-99	AA-8469	BC 1.12 (0.044)	Foam PE 2.95 (0.116)	36TC: Al Tape 3.66 (0.144)	XLPE 4.95 (0.195)	NA	0.055 (0.037)	50 ± 2 (83)	80.4 (24.5)	1,000	–30 +85 (–22 +185)	0.05 to 2.5 GHz, swept	Nonhalogen, low-smoke, low-loss
M17/220-00002	17-041-99	AA-8897	BC 1.12 (0.044)	Foam PE 2.95 (0.116)	36TC: Al Tape 3.66 (0.144)	XLPE 4.95 (0.195)	Al Braid 6.73 (0.265)	0.076 (0.051)	50 ± 2 (83)	80.4 (24.5)	1,000	–30 +85 (–22 +185)	0.05 to 2.5 GHz, swept	Armored M17/220-00001
M17/221-00001	17-041-99	AA-8470	BC 1.42 (0.056)	Foam PE 3.81 (0.150)	36TC: Al Tape 4.52 (0.178)	XLPE 6.15 (0.242)	NA	0.076 (0.051)	50 ± 2 (84)	79.4 (24.2)	1,500	–30 +85 (–22 +185)	0.05 to 2.5 GHz, swept	Nonhalogen, low-smoke, low-loss
M17/221-00002	17-041-99	AA-8898	BC 1.42 (0.056)	Foam PE 3.81 (0.150)	36TC: Al Tape 4.52 (0.178)	XLPE 6.15 (0.242)	Al Braid 7.92 (0.312)	0.098 (0.066)	50 ± 2 (84)	79.4 (24.2)	1,500	–30 +85 (–22 +185)	0.05 to 2.5 GHz, swept	Armored M17/221-00001
M17/222-00001	17-041-99	AA-8681	BC 1.78 (0.070)	Foam PE 4.83 (0.190)	34TC: Al Tape 5.72 (0.225)	XLPE 7.62 (0.300)	NA	0.130 (0.087)	50 ± 2 (85)	79.1 (24.1)	2,000	–30 +85 (–22 +185)	0.05 to 2.5 GHz, swept	Nonhalogen, low-smoke, low-loss
M17/222-00002	17-041-99	AA-8899	BC 1.78 (0.070)	Foam PE 4.83 (0.190)	34TC: Al Tape 5.72 (0.225)	XLPE 7.62 (0.300	Al Braid 9.40 (0.370)	0.158 (0.105)	50 ± 2 (85)	79.1 (24.1)	2,000	–30 +85 (–22 +185)	0.05to2.5 GHz	Armored M17/222-00001
M17/223-00001	17-041-99	AA-8471	BCCAI 2.74 (0.108)	Foam PE 7.24 (0.285)	34TC: Al Tape 8.13 (0.320)	XLPE 10.29 (0.405)	NA	0.170 (0.114)	50 ± 2 (85)	78.4 (23.9)	3,000	–30 +85 (–22 +185)	0.05 to 2.5 GHz, swept	Nonhalogen, low-smoke, low-loss
M17/223-00002	17-041-99	AA-8900	BCCAI 2.74 (0.108)	Foam PE 7.24 (0.285)	34TC: Al Tape 8.13 (0.320)	XLPE 10.29 (0.405)	Al Braid 12.07 (0.475)	0.209 (0.140)	50 ± 2 (85)	78.4 (23.9)	3,000	–30 +85 (–22 +185)	0.05 to 2.5 GHz, swept	Armored M17/223-00001
M17/224-00001	17-041-99	AA-8472	BCCAI 3.61 (0.142)	Foam PE 9.40 (0.370)	30TC: Al Tape 10.39 (0.409)	XLPE 12.70 (0.500)	NA	0.197 (0.132)	50 ± 2 (86)	77.4 (23.6)	4,000	–30 +85 (–22 +185)	0.05 to 2.5 GHz, swept	Nonhalogen, low-smoke, low-loss
M17/224-00002	17-041-99	AA-8901	BCCAI 3.61 (0.142)	Foam PE 9.40 (0.370)	34TC: Al Tape 10.39 (0.409)	XLPE 12.70 (0.500)	Al Braid 14.48 (0.570)	0.243 (0.163)	50 ± 2 (86)	77.4 (23.6)	4,000	–30 +85 (–22 +185)	0.05 to 2.5 GHz, swept	Armored M17/224-00001
M17/225-00001	17-041-99	AA-8473	BCCAI 4.47 (0.176)	Foam PE 11.56 (0.455)	34TC: Al Tape 12.45 (0.490)	XLPE 14.99 (0.590)	NA	0.250 (0.168)	50 ± 2 (87)	76.8 (23.4)	5,000	–30 +85 (–22 +185)	0.05 to 2.5 GHz, swept	Nonhalogen, low-smoke, low-loss
M17/225-00002	17-041-99	AA-8902	BCCAI 4.47 (0.176)	Foam PE 11.56 (0.455)	34TC: Al Tape 12.45 (0.490)	XLPE 14.99 (0.590)	Al Braid 16.89 (0.665)	0.304 (0.204)	50 ± 2 (87)	76.8 (23.4)	5,000	–30 +85 (–22 +185)	0.05 to 2.5 GHz, swept	Armored M17/225-00001
M17/226-00001	17-041-99	AA-8474	BC Tube 6.65 (0.262)	Foam PE 17.27 (0.680)	30TC: Al Tape 18.59 (0.732)	XLPE 22.10 (0.870)	NA	0.559 (0.375)	50 ± 2 (87)	76.8 (23.4)	7,000	–30 +85 (–22 +185)	0.05 to 2.5 GHz, swept	Nonhalogen, low-smoke, low-loss
M17/226-00002	17-041-99	AA-8903	BC Tube 6.65 0.262 ()	Foam PE 17.27 (0.680)	30TC: Al Tape 18.59 (0.732)	XLPE 22.10 (0.870)	Al Braid 24.00 (0.945)	0.636 (0.427)	50 ± 2 (87)	76.8 (23.4)	7,000	–30 +85 (–22 +185)	0.05 to 2.5 GHz, swept	Armored M17/226-00001
M17/227-00001	17-041-99	AA-8475	BC Tube 8.86 (0.349)	Foam PE 23.37 (0.920)	30TC: Al Tape 24.69 (0.972)	XLPE 30.48 (1.200)	NA	1.022 (0.686)	50 ± 2 (88)	75.8 (23.1)	8,000	–30 +85 (–22 +185)	0.05 to 2.5 GHz, swept	Nonhalogen, low-smoke, low-loss
M17/227-00002	17-041-99	AA-8904	BC Tube 8.86 (0.349)	Foam PE 23.37 (0.920)	30TC: Al Tape 24.69 (0.972)	XLPE 30.48 (1.200)	Al Braid 33.02 (1.300)	1.129 (0.758)	50 ± 2 (88)	75.8 (23.1)	8,000	–30 +85 (–22 +185)	0.05 to 2.5 GHz, swept	Armored M17/227-00001

M17 Part No.	M17 OPL	TMS Part No.	Conductor mm (inches)	Dielectric mm (inches)	Shields mm (inches)	Jacket mm (inches)	Armor mm (inches)	Weight kg/m (lb/ft)	Impedance ohms Vp (%)	Capacitance pF/m (pF/ft)	Max Oper. Voltage VRMS	Temp. Range °C (°F)	M17 Test Freq	Comments
M17/228-00001	17-041-99	AA-8476	BC Tube 13.39 (0.527)	Foam PE 34.29 (1.350)	30TC: Al Tape 35.59 (1.401)	XLPE 42.42 (1.670)	NA	1.564 (1.05)	50 ± 2 (89)	74.8 (22.8)	10,000	–30 +85 (–22 +185)	0.05 to 2.5 GHz, swept	Nonhalogen, low-smoke, low-loss
M17/228-00002	17-041-99	AA-8905	BC Tube 13.39 (0.527)	Foam PE 34.29 (1.350)	30TC: Al Tape 35.59 (1.401)	XLPE 42.42 (1.670)	Al Braid 33.02 (1.300)	1.683 (1.13)	50 ± 2 (89)	74.8 (22.8)	10,000	–30 +85 (–22 +185)	0.05 to 2.5 GHz, swept	Armored M17/228-00001

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APPENDIX F. DEFINITIONS

adhesive: a polymeric compound, usually an epoxy, used to secure the optical fiber connector.

backlighting: a method of illuminating the fiber endface by launching incoherent light into the optical fiber core through the opposite end of the fiber.

backreflection (backscattering): the return of a portion of scattered light to the input end of a fiber; the scattering of light in the direction opposite its original propagation.

buffer: a material applied over the coating that may be used to protect an optical fiber from physical damage, providing mechanical isolation, protection, or both.

bend radius:

a. **long-term:** the minimum radius to which a cable, without tensile load, can be bent for its lifetime without causing broken fibers, a localized weakening of the fibers, or a permanent increase in attenuation.

b. **short term:** the minimum radius to which a cable can be bent while under the maximum installation load without causing broken fibers, a localized weakening of the fibers, or a permanent increase in cable attenuation.

cladding: the dielectric material surrounding the core of an optical fiber.

cleave: the process of separating an optical fiber by a controlled fracture of the glass for the purpose of obtaining a fiber end that is flat, smooth, and perpendicular to the fiber axis.

coating: a material put on a fiber during the drawing process to protect it from the environment.

coupling loss: the optical power loss suffered when light **is** coupled from one optical device to another.

degas: to remove entrapped bubbles from a viscous fluid by placing that fluid in a centrifuge or vacuum.

direct-lighting: a method of illuminating the fiber endface by projecting a light source onto the fiber.

ferrule: a mechanical fixture, generally a rigid tube, used to confine the stripped end of a fiber bundle or an optical fiber.

fiber (optical): a filament-shaped optical waveguide made of dielectric material.

f**iber-optical cable:** a fiber, multiple fibers, or a fiber bundle in a cable structure fabricated to meet optical mechanical and environmental specifications.

fiber-optical connector: a fiber-optical component normally assembled onto a single fiber and attached to an apparatus for the purpose of interconnecting or disconnecting fiber-optical cables.

glass transition temperature (T_g): the temperature above which an amorphous polymer displays viscous behavior caused by chain slip.

ground support equipment (GSE): nonflight equipment, systems, or devices specifically designed and developed for a direct physical or functional interface with flight hardware.

ground support systems (GSS): infrastructure and equipment (portable or fixed) that provides functional and/or physical support to ground support equipment. It does not directly interface with flight hardware, although it may supply commodities, power, or data that eventually reaches the flight hardware after being conditioned or controlled by ground support equipment.

ground systems (GS): ground support equipment, ground support systems, and facility ground support systems.

hackle: a surface irregularity characterized by a rippled or stepped break in the fiber, usually caused by improper cleaving.

insertion loss: the optical attenuation caused by the insertion of an extra optical component into an optical system.

installation load, maximum: the maximum load that can be applied along the axis of a cable during installation without breaking fibers or causing a permanent increase in the cable attenuation.

interferometer: an instrument that employs the interference of light waves for purposes of measurement.

laser: a device that produces coherent optical radiation by stimulated emission and amplification.

mode: in general, an electromagnetic field distribution that depends on a wavelength of light and material properties of the traveling medium; in guided wave propagation, such as through a waveguide or optical fiber, a distribution of electromagnetic energy that satisfies Maxwell's equations and boundary conditions; in terms of ray optics, a possible path followed by light rays dependent on index of refraction, wavelength of light, and waveguide dimensions.

multimode fiber: an optical fiber that will allow two or more bound modes to propagate in the core at the wavelengths of interest.

Optical Time Domain Reflectometry (OTDR) Backscattering Technique: a method for characterizing an optical fiber whereby an optical pulse is transmitted through the fiber and the optical power of the resulting light scattered and reflected back to the input is measured as a function of time.

peer verification: for the purposes of this handbook, an in-process examination that must be documented. The person performing the peer verification must be trained and certified in accordance with the requirements of this handbook.

pistoning: the axial movement of an optical fiber within a connector or connector ferrule.

pot life: the length of time that a catalyzed resin system takes to double its original viscosity.

radiant power, optical power, optical flux, radiant flux: the time rate of radiant flux.

reflection: the change in direction of an incident wave at an interface between two dissimilar media so that the wave returns partially or totally into the medium from which it originated.

refraction: the bending of a beam of light in transmission through an interface between two dissimilar media or in a medium whose refractive index is a continuous function of position, for example, graded index medium.

scoop-proof: for a mating plug connector, incapable of inadvertently contacting the mating receptacle and damaging the pins or electrically shorting the contacts (because of the long-shell design of the connector).

single-mode fiber: an optical fiber in which only the lowest-order bound mode can propagate at the wavelength of interest.

Soxhlet extraction: a process, similar to distillation, used to separate materials; uses relevant to this handbook include removing oils, resins, or other contaminants from cotton swabs or wipes.

splicing: an interconnection method for joining the ends of two optical fibers in a permanent or semipermanent fashion.

a. **chemical splice:** a permanent joint made with an adhesive such as ultraviolet-cured polymer or epoxy.

b. **fusion splice:** a splice accomplished by the application of localized heat sufficient to fuse or melt the ends of two lengths of optical fiber, forming a single, continuous optical fiber.

c. **mechanical splice:** a fiber splice accomplished by fixtures or materials, rather than by thermal fusion.

d. **splice enclosure:** a case used to surround all the spliced fibers to protect them from physical damage.

e. **splice tray:** a container used to organize and protect spliced fibers.

strength member: that part of a fiber-optical cable composed of Kevlar aramid yarn, steel strands, or fiberglass filaments, included to increase the tensile strength of the cable, and in some applications, to support the weight of the cable.

ultraviolet (UV): optical radiation for which the wavelengths are shorter than those for visible radiation that is approximately between 1 nanometer and 400 nanometers.

APPENDIX G. FIBER ENDFACE INSPECTION CRITERIA AFTER POLISHING

G.1 General Instructions

CAUTION

Fiber-optic terminals can be damaged by improper use of the inspection hardware.

The use of an ionizer is permitted during the performance of this procedure. Use of an ionizer will reduce rework and ensure more effective cleaning. The ceramic tip of the terminals has an electrostatic potential that will attract particulate after cleaning. Approval to use an ionizer will be shown in the work authorization document (WAD).

G.2 Inspection Method

Endfaces of fiber-optic terminals shall be inspected at 100× minimum, using either the FS-PP-Kit Fiber Inspection Probe or a microscope approved by the KSC Materials and Processes Control Program (see http://ne.ksc.nasa.gov/org/nelMP.htm). The following steps are required.

a. Clean the inspection scope using lint-free wiping cloths or wipers dampened with isopropyl alcohol. Allow the scope to air-dry. Verify that the inspection scope is visibly clean.

b. Evaluate each fiber endface in accordance with fiber-optic endface specifications. Record results as acceptable or unacceptable by terminal designation. The WAD developer may choose to use a terminal map or table to record the results.

c. If required, clean the fiber endface in accordance with the drawing specification. If there is no cleaning specification, create one. Multiple cleaning/inspecting cycles are acceptable. Record the number of cleanings by terminal designation. The WAD developer may choose to use a terminal map or table to record the results.

d. If cleaning was performed, reevaluate the fiber endface in accordance with fiber-optic endface specifications. Multiple cleaning/inspecting cycles are acceptable. Record final results as acceptable or unacceptable by terminal designation. The WAD developer may choose to use a terminal map or table to record the results.

G.3 Inspection Criteria

See Figure 15 through Figure 21 for examples of particles, film, scratches, cracks, chips, and spalls on optical-fiber endfaces.

Acceptable contacts for multimode fiber shall have the following:

- few or no discernable particles, light scratches, chips, or spalls (Particles may cover a total area of no greater than 3% of the fiber core area (see Figure 15, Figure 16, Figure 18, Figure 20, and Figure 21). Hand calculations of areas and viewscreen templates are acceptable methods for determining the obscured area. Contact Materials and Processes Engineering for assistance if required.),
- no film contamination on optical-fiber endfaces (see Figure 17),
- no more than four cracks with the start and end at the outer radius of the optical fiber end-face and that remain in the outer ¼ radius (i.e., the crack cannot propagate into the inner ¾ radius at a later date) (see Figure 19), and
- no cracks inside the inner ¾ radius of the optical-fiber endface (see Figure 19).

The ceramic tip surrounding each contact shall be visibly clean. If particulate or discoloration is present, clean the contact in accordance with the drawing specification. If there is no cleaning specification, clean in accordance with NASA-STD-8739.5. Following cleaning, contamination or discoloration that remained in place, undisturbed on the ceramic tip, is acceptable.

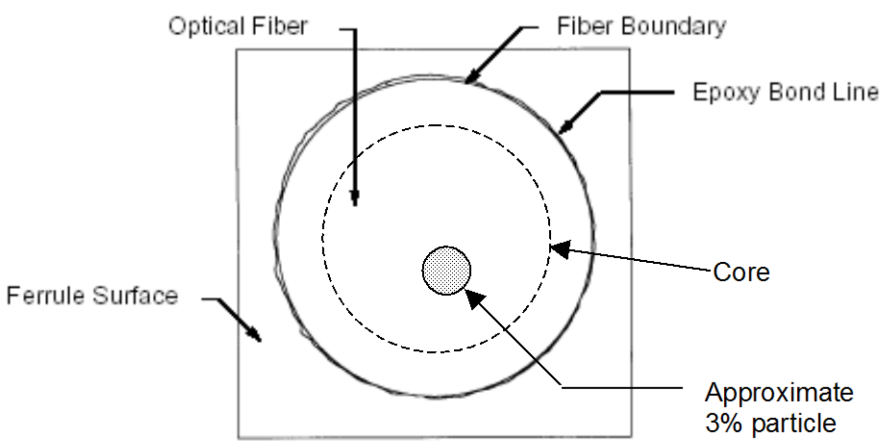

Figure 15. Typical Endface of an Optical Fiber

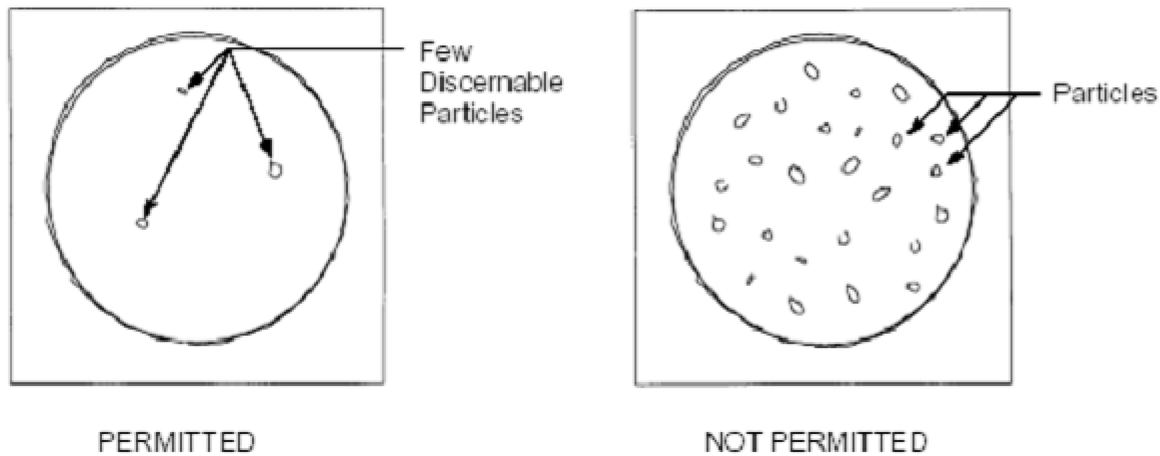

Figure 16. Particle Contamination of the Endface of an Optical Fiber

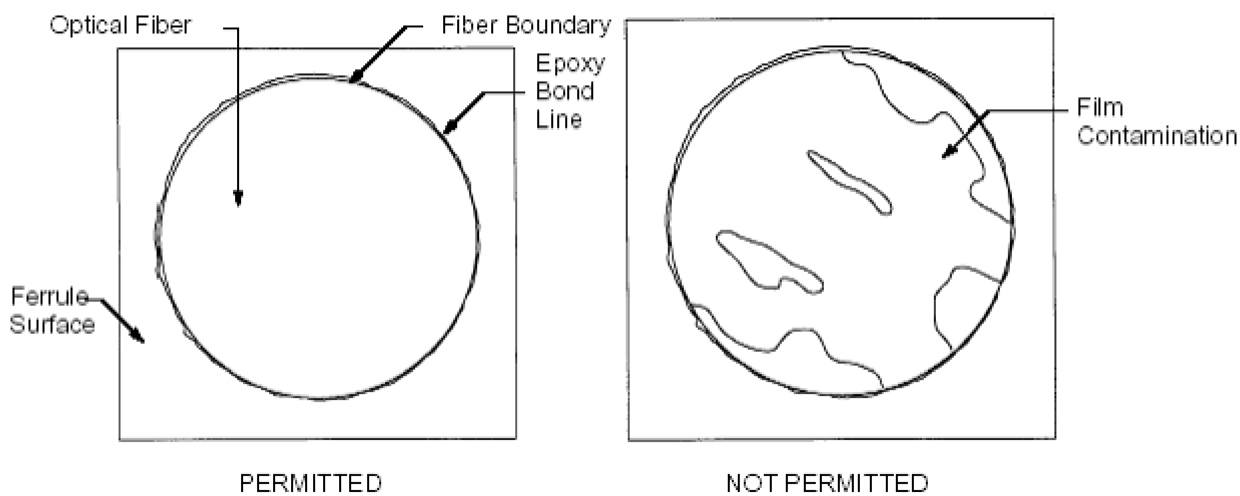

Figure 17. Film Contamination of the Endface of an Optical Fiber

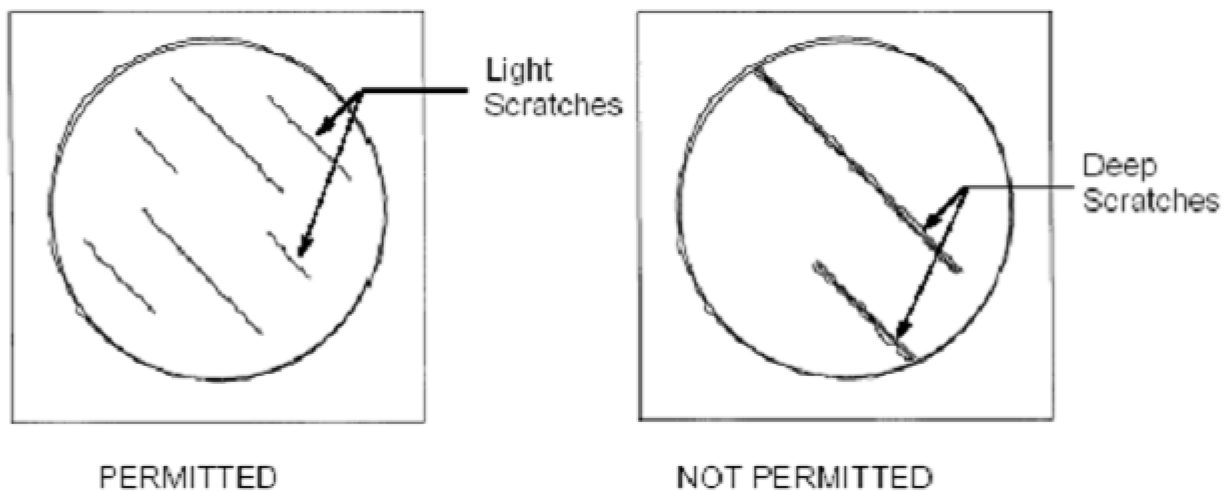

Figure 18. Examples of Scratches on the Endface of an Optical Fiber

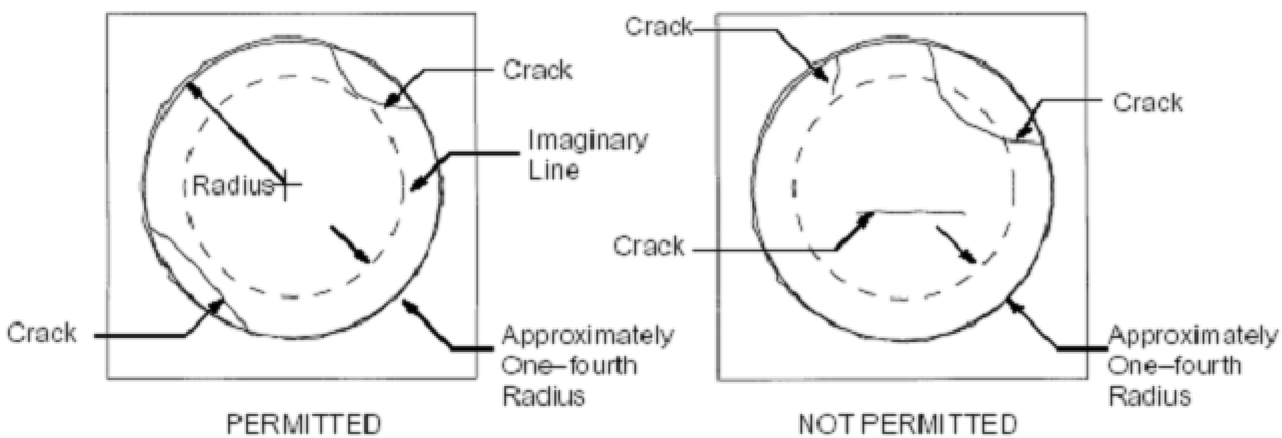

Figure 19. Cracks on the Endface of an Optical Fiber

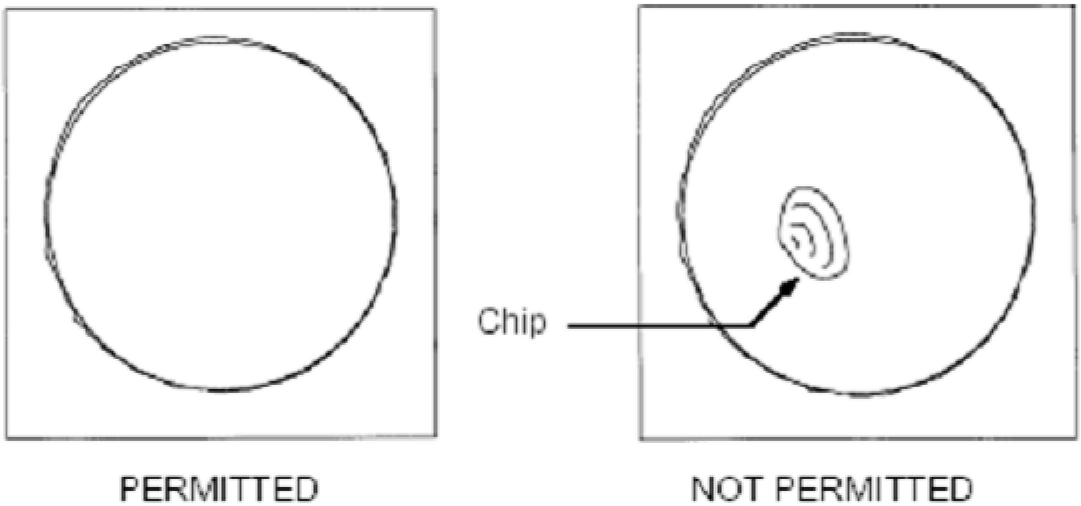

Figure 20. Example of a Chip on the Endface of an Optical Fiber

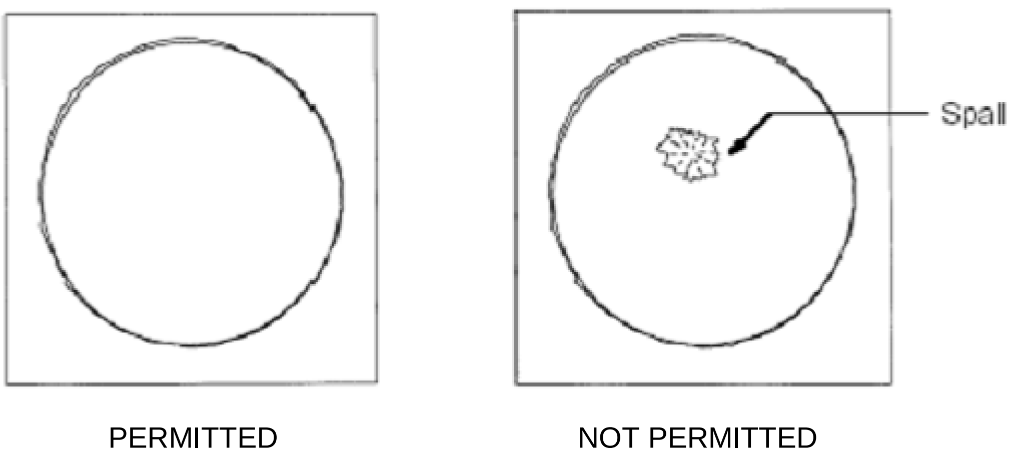

Figure 21. Example of a Spall on the Endface of an Optical Fiber

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3. DOCUMENT TITLE
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4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

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a. NAME *(Last, First, Middle Initial)*	b. ORGANIZATION
Denson, Erik C.	Engineering Directorate, Electrical Division

c. ADDRESS *(Include zip code)*
Kennedy Space Center, FL 32899

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